PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2004-112748
(43)Date of publication of application : 08.04.2004

(51)Int.CI. H03H 9/145
H03H 3/08
H03H 9/25

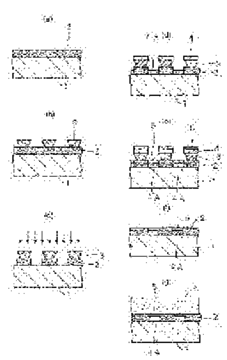
(21)Application number : 2003-041480
(22)Date of filing : 19.02.2003

(71)Applicant : MURATA MFG CO LTD
(72)Inventor : KADOTA MICHIO
NAKAO TAKESHI
NISHIYAMA KENJI

(30)Priority

Priority number : 2002215614 Priority date : 24.07.2002 Priority country : JP

(54) SURFACE ACOUSTIC WAVE APPARATUS AND MANUFACTURING METHOD THEREFOR



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a manufacturing method for a surface acoustic wave (SAW) apparatus in which deterioration of characteristics caused by unwanted ripple is suppressed by sufficiently enlarging the reflection coefficient of an IDT in the SAW apparatus equipped with a structure formed with an insulating layer to cover an IDT electrode.

SOLUTION: In the SAW apparatus, a first insulating layer 2 is formed on the entire surface of a piezoelectric LiTaO3 substrate. By using a resist pattern 3 used for forming the IDT electrode, the first insulating layer 2 in which the IDT electrode is to be formed is removed. An electrode film made of a metal having a density higher than Al or of an alloy primarily including such a metal is disposed in the area in which the first insulating layer is removed so as to form an IDT electrode 4A. The resist pattern remaining on the first insulating layer is removed. A second insulating layer 6 is formed to cover the first insulating layer 2 and the IDT electrode 4A.

LEGAL STATUS

[Date of request for examination]	30.11.2004
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]
[Claim 1]
The piezoelectric substrate with which an electromechanical coupling coefficient consists of 15% or more of $LiTaO_3$ or $LiNbO_3$,
At least one electrode which is formed on said piezoelectric substrate and consists of cascade screens which consist of an alloy which uses the large metal or this metal of a consistency as a principal component, and other metals rather than the alloy which uses the large metal or this metal of a consistency as a principal component rather than aluminum, or aluminum,
The 1st insulating material layer which was in said electrode, abbreviation, etc. by carrying out in the remaining fields except the field in which said at least one electrode is formed, and was formed in thickness,
It has the 2nd insulating material layer formed so that said electrode and the 1st insulating material layer might be covered,
Surface acoustic wave equipment whose consistency of said electrode is 1.5 or more times of said 1st insulating material layer.
[Claim 2]
Piezoelectric substrate,
At least one electrode formed on said piezoelectric substrate,
The protection metal membrane which consists of the metal or alloy which excelled the metal or alloy which is formed on said electrode and constitutes an electrode in corrosion resistance,
The 1st insulating material layer formed so that the thickness of the sum total of said electrode and protection metal membrane, abbreviation, etc. might be by carrying out in the remaining fields except the field in which said at least one electrode is formed and it might have thickness,
Surface acoustic wave equipment equipped with the 2nd insulating material layer formed so that said protection metal membrane and the 1st insulating material layer might be covered.
[Claim 3]
Surface acoustic wave equipment according to claim 2 whose mean density of the whole laminated structure of said electrode and a protection metal membrane is 1.5 or more times of the consistency of said 1st insulating material layer.
[Claim 4]
Surface acoustic wave equipment according to claim 1 to 3 with which the

said 1st and 2nd insulating material layer is formed of SiO_2.
[Claim 5]
Surface acoustic wave equipment according to claim 1 to 4 which is surface acoustic wave equipment using reflection of a surface acoustic wave.
[Claim 6]
Said piezoelectric substrate is $LiTaO_3$ substrate of an Eulerian angle (0**3 degrees, 104 degrees - 140 degrees, 0**3 degrees). When wavelength of Hs and a surface acoustic wave is set to lambda, the sum total thickness of SiO_2 film which the said 1st and 2nd insulating material layer consists of SiO_2, and constitutes the 1st and 2nd insulating material layer Surface acoustic wave equipment according to claim 1 to 5 made into the value with which standardization thickness H/lambda of an electrode fills the following formula (1) when Hs/lambda is made into the range of 0.03-0.45 and sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode.
0.005 <= H/lambda <=0.00025xrho2-0.01056xrho+0.16473 (however, rho mean density of an electrode) -- Formula (1)
[Claim 7]
Said piezoelectric substrate is $LiTaO_3$ substrate of an Eulerian angle (0**3 degrees, 115 degrees - 148 degrees, 0**3 degrees), the said 1st and 2nd insulating material layer consists of SiO_2 film, and standardization thickness Hs/lambda of the sum total of SiO_2 film is in the range of 0.03-0.45,
Surface acoustic wave equipment given in either of claims 1, 4-6 which has standardization thickness H/lambda in the range of 0.013-0.032 when a consistency 15000 - 23000 kg/m3 and Young's modulus 0.5x1011 - 1.0x1011 N/m2, or transverse-wave acoustic velocity is the metal which is 1000 - 2000 m/s and a metal with a larger consistency than said aluminum sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode.
[Claim 8]
Surface acoustic wave equipment according to claim 7 said whose metal is Au.
[Claim 9]
Surface acoustic wave equipment according to claim 7 or 8 which has the Eulerian angle of said $LiTaO_3$ substrate in the range of (0**3 degrees, 132 degrees - 148 degrees, 0**3 degrees).
[Claim 10]
Surface acoustic wave equipment according to claim 7 or 8 which has theta of the Eulerian angle of said $LiTaO_3$ substrate in the range of 115

degrees or more and less than 132 degrees.
[Claim 11]
Surface acoustic wave equipment according to claim 7 or 8 whose standardization thickness Hs/lambda of SiO2 which constitutes standardization thickness H/lambda and the 1st and 2nd insulating material layer of the Eulerian angle (0**3 degrees, theta, 0**3 degrees) of said LiTaO3 substrate and said electrode is either of the combination shown in the following table 1.
[Table 1]

オイラー角 (0±3°, θ, 0±3°) のθ	Au膜厚	SiO_2膜厚
120.0° ≦θ<123.0°	0.013～0.018	0.15～0.45
123.0° ≦θ<124.5°	0.013～0.022	0.10～0.40
124.5° ≦θ<125.5°	0.013～0.025	0.07～0.40
125.5° ≦θ<127.5°	0.013～0.025	0.06～0.40
127.5° ≦θ<129.0°	0.013～0.028	0.04～0.40
129.0° ≦θ<130.0°	0.017～0.030	0.03～0.42
130.0° ≦θ<131.5°	0.017～0.030	0.03～0.42
131.5° ≦θ<133.0°	0.018～0.028	0.05～0.33
133.0° ≦θ<135.0°	0.018～0.030	0.05～0.30
135.0° ≦θ≦137.0°	0.019～0.032	0.05～0.25
137.0° ≦θ≦140.0°	0.019～0.032	0.05～0.25

[Claim 12]
Surface acoustic wave equipment according to claim 7 or 8 whose standardization thickness Hs/lambda of SiO2 which constitutes standardization thickness H/lambda and the 1st and 2nd insulating material layer of the Eulerian angle (0**3 degrees, theta, 0**3 degrees) of said LiTaO3 substrate and said electrode is either of the combination shown in the following table 2.
[Table 2]

オイラー角 (0±3°，θ，0±3°) のθ	Ａｕ膜厚	SiO_2膜厚
129.0° ≦θ＜130.0°	0.022～0.028	0.04～0.40
130.0° ≦θ＜131.5°	0.022～0.028	0.04～0.40
131.5° ≦θ＜133.0°	0.022～0.028	0.05～0.33
133.0° ≦θ＜135.0°	0.022～0.030	0.05～0.30
135.0° ≦θ＜137.0°	0.022～0.032	0.05～0.25
137.0° ≦θ≦140.0°	0.022～0.032	0.05～0.25

[Claim 13]
Said piezoelectric substrate is LiTa03 substrate of an Eulerian angle (0**3 degrees, 113 degrees - 142 degrees, 0**3 degrees), said 1st and 2nd insulating material layer consists of SiO2 film, and standardization thickness Hs/lambda of the sum total of SiO2 film is in the range of 0.10-0.40,
Surface acoustic wave equipment given in either of claims 1, 4-6 which has standardization thickness H/lambda in the range of 0.01-0.08 when a consistency 5000 - 15000 kg/m3 and Young's modulus 0.5x1011 - 1.0x1011 N/m2, or transverse-wave acoustic velocity is the metal which is 1000 - 2000 m/s and a metal with a larger consistency than said aluminum sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode.
[Claim 14]
Surface acoustic wave equipment according to claim 13 said whose metal is Ag.
[Claim 15]
Surface acoustic wave equipment according to claim 13 or 14 standardization thickness Hs/lambda of the sum total of said SiO2 film and whose Eulerian angle of LiTa03 substrate standardization thickness H/lambda of said electrode is 0.01-0.08, and are either of the combination shown in the following table 3.
[Table 3]

Ａｇ膜厚Ｈ／λ：０．０１～０．０８のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角
０．１５～０．１８	０±３，１１７～１３７，０±３
０．１８～０．２３	０±３，１１７～１３６，０±３
０．２３～０．２８	０±３，１１５～１３５，０±３
０．２８～０．３３	０±３，１１３～１３３，０±３
０．３３～０．３８	０±３，１１３～１３５，０±３
０．３８～０．４０	０±３，１１３～１３２，０±３

[Claim 16]
Surface acoustic wave equipment according to claim 13 or 14 standardization thickness Hs/lambda of the sum total of said SiO2 film and whose Eulerian angle of LiTaO3 substrate standardization thickness H/lambda of said electrode is 0.02-0.06, and are either of the combination shown in the following table 4.
[Table 4]

Ａｇ膜厚Ｈ／λ：０．０２～０．０６のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角
０．１５～０．１８	０±３，１２０～１３３，０±３
０．１８～０．２３	０±３，１２０～１３７，０±３
０．２３～０．２８	０±３，１２０～１３５，０±３
０．２８～０．３３	０±３，１１８～１３５，０±３
０．３３～０．３８	０±３，１１５～１３３，０±３
０．３８～０．４０	０±３，１１３～１３０，０±３

[Claim 17]
Surface acoustic wave equipment according to claim 13 or 14 standardization thickness Hs/lambda of the sum total of said SiO2 film and whose Eulerian angle of LiTaO3 substrate standardization thickness H/lambda of said electrode is 0.03-0.05, and are either of the combination shown in the following table 5.
[Table 5]

Ａｇ膜厚Ｈ／λ：０．０３～０．０５のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角
０．１５～０．１８	０±３，１２２～１４２，０±３
０．１８～０．２３	０±３，１２０～１４０，０±３
０．２３～０．２８	０±３，１１７～１３８，０±３
０．２８～０．３３	０±３，１１６～１３６，０±３
０．３３～０．３８	０±３，１１４～１３５，０±３
０．３８～０．４０	０±３，１１３～１３０，０±３

[Claim 18]
Said piezoelectric substrate is LiTa03 substrate of an Eulerian angle (0**3 degrees, 113 degrees - 137 degrees, 0**3 degrees), said 1st and 2nd insulating material layer consists of Si02 film, and standardization thickness Hs/lambda of the sum total of Si02 film is in the range of 0.10-0.40,
Surface acoustic wave equipment given in either of claims 1, 4-6 which has standardization thickness H/lambda in the range of 0.01-0.08 when a consistency 5000 - 15000 kg/m3 and Young's modulus 1.0x1011 - 2.05x1011 N/m2, or transverse-wave acoustic velocity is the metal which is 2000 - 2800 m/s and a metal with a larger consistency than said aluminum sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode.
[Claim 19]
Surface acoustic wave equipment according to claim 18 said whose metal is Cu.
[Claim 20]
Surface acoustic wave equipment according to claim 18 or 19 whose standardization thickness Hs/lambda of the Eulerian angle of said LiTa03 substrate and said sum total of Si02 is either of the combination shown in the following table 6.
[Table 6]

SiO_2膜厚	$LiTaO_3$のオイラー角
0．15～0．18	(0±3，117～137，0±3)
0．18～0．23	(0±3，117～136，0±3)
0．23～0．28	(0±3，115～135，0±3)
0．28～0．33	(0±3，113～133，0±3)
0．33～0．38	(0±3，113～135，0±3)
0．38～0．4	(0±3，113～132，0±3)

[Claim 21]
Surface acoustic wave equipment according to claim 18 or 19 characterized by theta of said Eulerian angle (0**3 degrees, theta, 0**3 degrees) being in the range of the following formula (2).
thetamin-2 degree< theta<=theta min+2 degree -- Formula (2)
However, among a formula (2), thetamin is a value expressed with following formula A-E, respectively, when standardization thickness H/lambda of IDT is the range of following (a) - (e).
(a) At the time of 0< H/lambda <=0.01
thetamin=-139.713xHs3+43.07132xHs2-20.568011xHs+125.8314 -- At the time of formula A(b)0.01< H/lambda <=0.03
thetamin=-139.660xHs3+46.02985xHs2-21.141500xHs+127.4181 -- At the time of formula B(c)0.03< H/lambda <=0.05
thetamin=-139.607xHs3+48.98838xHs2-21.714900xHs+129.0048 -- At the time of formula C(d)0.05< H/lambda <=0.07
thetamin=-112.068xHs3+39.60355xHs2-21.186000xHs+129.9397 -- At the time of formula D(e)0.07< H/lambda <=0.09
thetamin=-126.954xHs3+67.40488xHs2
- 29.432000xHs+131.5686 -- Formula E
[Claim 22]
Surface acoustic wave equipment according to claim 18 or 19 standardization thickness Hs/lambda of the sum total of said SiO2 film and whose Eulerian angle of LiTaO3 substrate are either of the combination shown in the following table 7.
[Table 7]

SiO_2膜厚	$LiTaO_3$のオイラー角
0．15～0．18	(0±3，117～125，0±3)
0．18～0．23	(0±3，117～125，0±3)
0．23～0．28	(0±3，115～125，0±3)
0．28～0．33	(0±3，113～125，0±3)
0．33～0．38	(0±3，113～125，0±3)
0．38～0．40	(0±3，113～125，0±3)

[Claim 23]
Said piezoelectric substrate is LiTa03 substrate of an Eulerian angle (0**3 degrees, 112 degrees - 138 degrees, 0**3 degrees), said 1st and 2nd insulating material layer consists of Si02 film, and standardization thickness Hs/lambda of the sum total of Si02 film is in the range of 0.10-0.40,
Surface acoustic wave equipment given in either of claims 1, 4-6 which has standardization thickness H/lambda in the range of 0.025-0.06 when a consistency 15000 - 23000 kg/m3 and Young's modulus 2.0x1011 - 4.5x1011 N/m2, or transverse-wave acoustic velocity is the metal which is 2800 - 3500 m/s and a metal with a larger consistency than said aluminum sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode.
[Claim 24]
Surface acoustic wave equipment according to claim 23 said whose metal is a tungsten.
[Claim 25]
Surface acoustic wave equipment according to claim 23 or 24 which has said standardization thickness H/lambda of IDT in the range of 0.012-0.053.
[Claim 26]
Surface acoustic wave equipment according to claim 25 which has said standardization thickness H/lambda of IDT in the range of 0.015-0.042.
[Claim 27]
Surface acoustic wave equipment according to claim 23 to 25 said whose LiTa03 substrate is LiTa03 substrate of an Eulerian angle (0**3 degrees, 115 degrees - 135 degrees, 0**3 degrees).
[Claim 28]
Surface acoustic wave equipment according to claim 23 or 24 standardization thickness H/lambda of said electrode is 0.012-0.053, and

is [equipment] either of the combination which standardization thickness Hs/lambda of the sum total of said SiO2 film and the Eulerian angle of LiTaO3 substrate show in the following table 8.
[Table 8]

電極のH/λ＝0.012～0.053のとき

SiO_2の規格化膜厚	$LiTaO_3$のオイラー角
0.1～0.15	(0±3, 114.2～138, 0±3)
0.15～0.2	(0±3, 113～137.8, 0±3)
0.2～0.3	(0±3, 113～137.5, 0±3)
0.3～0.35	(0±3, 112.7～137, 0±3)
0.35～0.4	(0±3, 112.5～136, 0±3)

[Claim 29]
Surface acoustic wave equipment according to claim 23 or 24 standardization thickness H/lambda of said electrode is 0.015-0.042, and is [equipment] either of the combination which standardization thickness Hs/lambda of the sum total of said SiO2 film and the Eulerian angle of LiTaO3 substrate show in the following table 9.
[Table 9]

電極のH/λ＝0.015～0.042のとき

SiO_2の規格化膜厚	$LiTaO_3$のオイラー角
0.1～0.15	(0±3, 114.3～138, 0±3)
0.15～0.2	(0±3, 113～137.5, 0±3)
0.2～0.3	(0±3, 112.5～137, 0±3)
0.3～0.35	(0±3, 112.2～136.5, 0±3)
0.35～0.4	(0±3, 112～135.3, 0±3)

[Claim 30]
Said piezoelectric substrate is LiTaO3 substrate of an Eulerian angle (0**3 degrees, 104 degrees - 148 degrees, 0**3 degrees), said 1st and 2nd insulating material layer consists of SiO2 film, and standardization thickness Hs/lambda of the sum total of SiO2 film is in the range of 0.10-0.40,
Surface acoustic wave equipment given in either of claims 1, 4-6 which has standardization thickness H/lambda in the range of 0.004-0.055 when

a consistency 15000 - 23000 kg/m3 and Young's modulus 1.0x1011 - 2.0x1011 N/m2, or transverse-wave acoustic velocity is the metal which is 2000 - 2800 m/s and a metal with a larger consistency than said aluminum sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode.

[Claim 31]

Surface acoustic wave equipment according to claim 30 said whose metal is a tantalum.

[Claim 32]

Surface acoustic wave equipment according to claim 30 or 31 which has standardization thickness H/lambda of said electrode in the range of 0.01-0.55.

[Claim 33]

Surface acoustic wave equipment according to claim 30 or 31 which has standardization thickness H/lambda of said electrode in the range of 0.016-0.045.

[Claim 34]

Surface acoustic wave equipment according to claim 30 to 32 said whose piezoelectric substrate is LiTaO3 substrate of an Eulerian angle (0**3 degrees, 111 degrees - 143 degrees, 0**3 degrees).

[Claim 35]

Surface acoustic wave equipment according to claim 30 or 31 standardization thickness H/lambda of said electrode is 0.01-0.055, and is [equipment] either of the combination which standardization thickness Hs/lambda of the sum total of said SiO2 film and the Eulerian angle of LiTaO3 substrate show in the following table 10.

[Table 10]

電極の H/λ＝0.01～0.055 のとき

SiO_2の規格化膜厚	$LiTaO_3$のオイラー角
0.1～0.15	(0±3, 110.5～148, 0±3)
0.15～0.2	(0±3, 108～147.5, 0±3)
0.2～0.3	(0±3, 105～148, 0±3)
0.3～0.35	(0±3, 104.5～148, 0±3)
0.35～0.4	(0±3, 104～145, 0±3)

[Claim 36]

Surface acoustic wave equipment according to claim 30 or 31 standardization thickness Hs/lambda of the sum total of said SiO2 film

and whose Eulerian angle of LiTa03 substrate standardization thickness H/lambda of said electrode is 0.016-0.045, and are either of the combination shown in the following table 11.
[Table 11]

電極のH/λ＝0.016～0.045のとき

SiO_2の規格化膜厚	$LiTaO_3$のオイラー角
0.1～0.15	(0±3, 113～144, 0±3)
0.15～0.2	(0±3, 111～144, 0±3)
0.2～0.3	(0±3, 108～144, 0±3)
0.3～0.35	(0±3, 107.5～143, 0±3)
0.35～0.4	(0±3, 107～140.5, 0±3)

[Claim 37]
Said piezoelectric substrate is LiTa03 substrate of an Eulerian angle (0**3 degrees, 90 degrees - 169 degrees, 0**3 degrees), said 1st and 2nd insulating material layer consists of Si02 film, and standardization thickness Hs/lambda of the sum total of Si02 film is in the range of 0.10-0.40,
Surface acoustic wave equipment given in either of claims 1, 4-6 which has standardization thickness H/lambda in the range of 0.005-0.054 when a consistency 15000 - 23000 kg/m3 and Young's modulus 1.0x1011 - 2.0x1011 N/m2, or transverse-wave acoustic velocity is the metal of 1000 - 2000 m/s and a metal with a larger consistency than said aluminum sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode.
[Claim 38]
Surface acoustic wave equipment according to claim 37 said whose metal is platinum.
[Claim 39]
Surface acoustic wave equipment according to claim 37 or 38 which whose Eulerian angles of said piezoelectric substrate are (0**3 degrees, 90 degrees - 155 degrees, 0**3 degrees), and has standardization thickness H/lambda of said electrode in the range of 0.01-0.04.
[Claim 40]
Surface acoustic wave equipment according to claim 39 whose standardization thickness Hs/lambda of the Eulerian angle of said LiTa03 substrate and said sum total of Si02 is either of the combination shown in the following table 12.

[Table 12]

白金 H/λ＝0.01～0.04 のとき

SiO_2厚(Hs/λ)	オイラー角
0.1 ≦ Hs/λ＜0.15	(0±3°, 90°～169°, 0±3°)
0.15≦ Hs/λ＜0.2	(0±3°, 90°～167°, 0±3°)
0.20≦ Hs/λ＜0.25	(0±3°, 90°～167°, 0±3°)
0.25≦ Hs/λ＜0.3	(0±3°, 90°～164°, 0±3°)
0.3 ≦ Hs/λ＜0.4	(0±3°, 90°～163°, 0±3°)

[Claim 41]
Surface acoustic wave equipment according to claim 37 or 38 which whose Eulerian angles of said piezoelectric substrate are (0**3 degrees, 102 degrees - 150 degrees, 0**3 degrees), and has standardization thickness H/lambda of said electrode in the range of 0.013-0.033.
[Claim 42]
Surface acoustic wave equipment according to claim 41 standardization thickness Hs/lambda of the sum total of said SiO2 film and whose Eulerian angle of LiTaO3 substrate are either of the combination shown in the following table 13.
[Table 13]

白金 H/λ＝0.013～0.033 のとき

SiO_2厚(Hs/λ)	オイラー角
0.1 ≦ Hs/λ＜0.15	(0±3°, 106°～155°, 0±3°)
0.15≦ Hs/λ＜0.2	(0±3°, 104°～155°, 0±3°)
0.20≦ Hs/λ＜0.25	(0±3°, 102°～155°, 0±3°)
0.25≦ Hs/λ＜0.3	(0±3°, 102°～154°, 0±3°)
0.3 ≦ Hs/λ＜0.4	(0±3°, 102°～153°, 0±3°)

[Claim 43]
Said piezoelectric substrate is LiTaO3 substrate of an Eulerian angle (0**3 degrees, 104 degrees - 150 degrees, 0**3 degrees), said 1st and 2nd insulating material layer consists of SiO2 film, and standardization thickness Hs/lambda of the sum total is in the range of 0.10-0.40, Surface acoustic wave equipment given in either of claims 1, 4-6 which has standardization thickness H/lambda in the range of 0.008-0.06 when a

consistency 5000 - 15000 kg/m3 and Young's modulus 2.0x1011 - 4.5x1011 N/m2, or transverse-wave acoustic velocity consists of a metal of 2800 - 3500 m/s and a metal with a larger consistency than said aluminum sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode.

[Claim 44]

Surface acoustic wave equipment according to claim 43 said whose metal is nickel.

[Claim 45]

Surface acoustic wave equipment according to claim 44 which has standardization thickness H/lambda of said electrode in the range of 0.02-0.06.

[Claim 46]

Surface acoustic wave equipment according to claim 44 which has standardization thickness H/lambda of said electrode in the range of 0.027-0.06.

[Claim 47]

Surface acoustic wave equipment according to claim 44 the Eulerian angle of said LiTaO3 substrate and whose standardization thickness Hs/lambda of the sum total of said SiO2 film are either of the combination shown in the following table 14.

[Table 14]

SiO_2膜厚	オイラー角
0.1～0.2	(0±3°, 106°～140°, 0±3°)
0.2～0.3	(0±3°, 105°～137°, 0±3°)
0.3～0.4	(0±3°, 104°～133°, 0±3°)

[Claim 48]

Surface acoustic wave equipment according to claim 43 with which said metal consists of Mo.

[Claim 49]

Surface acoustic wave equipment according to claim 48 which has standardization thickness H/lambda of said electrode in the range of 0.017-0.06.

[Claim 50]

Surface acoustic wave equipment according to claim 48 which has standardization thickness H/lambda of said electrode in the range of 0.023-0.06.

[Claim 51]
Surface acoustic wave equipment according to claim 48 the Eulerian angle of said LiTaO3 substrate and whose standardization thickness Hs/lambda of the sum total of said SiO2 film are either of the combination shown in the following table 15.
[Table 15]

SiO_2膜厚	オイラー角
0.1～0.2	(0±3°, 107°～141°, 0±3°)
0.2～0.3	(0±3°, 104°～141°, 0±3°)
0.3～0.4	(0±3°, 104°～138°, 0±3°)

[Claim 52]
Surface acoustic wave equipment given in either of claims 1, 4-6 which is rho0x0.7 <= rho<=rho 0x1.3 when said electrode consists of a cascade screen of the main electrode layer which consists of the large metal or large alloy of a consistency rather than aluminum, and at least one electrode layer which consists of other metals and sets the consistency of a metal with a large consistency to rho 0 rather than the mean density rho and said aluminum of this electrode.
[Claim 53]
Surface acoustic wave equipment according to claim 1 to 52 whose irregularity of said 2nd insulating material layer front face is 30% or less of the thickness of said electrode.
[Claim 54]
Surface acoustic wave equipment according to claim 1 to 53 characterized by using a leakage type surface acoustic wave as a surface acoustic wave.
[Claim 55]
The process which prepares a piezoelectric substrate,
The process which forms the 1st insulating material layer all over one side of said piezoelectric substrate,
The process which makes the laminated structure of the 1st insulating material layer and a resist remain to the remaining fields while removing the 1st insulating material layer of the part in which said electrode is formed using the resist pattern for forming the electrode pattern which has at least one electrode,
The process which the electrode layer which consists of an alloy which uses the metal or this metal of high density as a principal component is in the 1st insulating material layer, abbreviation, etc. rather than

aluminum by making it the field to which said 1st insulating material layer is removed, forms in thickness, and forms at least one electrode,
The process which removes the resist which remains on said 1st insulating material layer,
The manufacture approach of surface acoustic wave equipment equipped with the process which forms the 2nd insulating material layer so that a said 1st insulating material layer and electrode top may be covered.
[Claim 56]
The manufacture approach of surface acoustic wave equipment according to claim 55 that the consistency of the metal which constitutes said electrode, or an alloy is 1.5 or more times of the consistency of said 1st insulating material layer.
[Claim 57]
The process which prepares a piezoelectric substrate,
The process which forms the 1st insulating material layer on the whole surface of one side of said piezoelectric substrate,
The process which the 1st insulating material layer of the field of a part in which said electrode is formed using the resist pattern for forming at least one electrode pattern is removed [process], and makes the laminated structure of the 1st insulating material layer and a resist remain to the remaining fields,
The process which forms the metal or alloy film for forming an electrode in the field to which said 1st insulating material layer is removed, and forms an electrode in it,
The process which forms the protection metal membrane which consists of a metal or an alloy excellent in corrosion resistance all over this electrode, and said protection metal membrane is in the height of said 1st insulating material layer, abbreviation, etc. by carrying out, and forms it in height rather than the metal or alloy which constitutes this electrode after forming said electrode,
The process which removes the protection metal membrane by which the laminating is carried out on the resist on said 1st insulating material layer, and this resist,
The manufacture approach of the surface acoustic wave equipment equipped with the process which forms the 2nd insulating material layer so that the protection metal membrane formed on said electrode and said 1st insulating material layer may be covered.
[Claim 58]
The manufacture approach of surface acoustic wave equipment according to claim 57 that the metal or alloy which constitutes said electrode configuration metal or alloy, and said protection metal membrane so that

the mean density of the laminated structure which consists of said electrode and a protection metal membrane may become 1.5 or more times of the consistency of the 1st insulating material layer is chosen.

[Claim 59]

The process which prepares a piezoelectric substrate,

The process which forms an electrode on said piezoelectric substrate,

The process which forms an insulating material layer so that said electrode may be covered,

The manufacture approach of surface acoustic wave equipment equipped with the process which carries out flattening of the irregularity of the insulating material layer above the part in which said electrode exists, and the part not existing.

[Claim 60]

The manufacture approach of surface acoustic wave equipment according to claim 59 that said flattening process is performed by etchback, a reverse spatter, or polish.

[Claim 61]

The manufacture approach of surface acoustic wave equipment according to claim 55 to 59 using SiO2 as said insulating material layer using one sort chosen as Au, Cu, Ag, W, Ta, Pt, nickel, and Mo list from the group which consists of an alloy which uses these metals as a principal component as a metal which constitutes said electrode.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to the surface acoustic wave equipment which

equipped the detail with the structure where the insulating material layer is formed so that an IDT electrode may be covered, more, and its manufacture approach about the surface acoustic wave equipment used for a resonator, a band-pass filter, etc., and its manufacture approach.

[0002]

[Description of the Prior Art]

It is called for that a broadband and the both sides of the good temperature characteristic are filled with DPX used for mobile communication system or RF filter. Conventionally, with the surface acoustic wave equipment used for DPX or RF filter, the piezoelectric substrate which consists of 36 degrees - 50 degree rotation Y cut X propagation $LiTaO_3$ is used. The frequency temperature coefficient of this piezoelectric substrate was about -40--30ppm/degree C. In order to improve the temperature characteristic, the approach of forming SiO_2 film which has a forward frequency temperature coefficient so that an IDT electrode may be covered on a piezoelectric substrate is learned. An example of the manufacture approach of this kind of surface acoustic wave equipment is shown in drawing 109 .

[0003]

As shown in drawing 109 (a), except for the part in which an IDT electrode is formed, a resist pattern 52 is formed on the piezoelectric substrate 51. Next, as shown in drawing 109 (b), the electrode layer 53 for forming an IDT electrode in the whole surface is formed. After an appropriate time, the metal membrane which has adhered on a resist 52 and a resist 52 is removed using resist exfoliation liquid. Thus, as shown in drawing 109 (c), IDT electrode 53A is formed. Next, as shown in drawing 109 (d), SiO_2 film 54 is formed so that IDT electrode 53A may be covered.

[0004]

On the other hand, it is the purpose different from an improvement of the above-mentioned frequency temperature characteristic, and the manufacture approach of surface acoustic wave equipment that the insulating or anti-conductive protective coat is formed so that the IDT electrode of surface acoustic wave equipment may be covered is indicated by the following patent reference 1. Drawing 110 is a typical sectional view showing the surface wave equipment of a publication in this advanced technology. With surface acoustic wave equipment 61, the IDT electrode 63 which consists of an alloy which uses aluminum or aluminum as a principal component is formed on the piezo-electric substrate 62. The insulating or anti-conductive electrode finger mesenteriolum 64 is formed in fields other than the field in which the IDT electrode 63 is

formed. Moreover, the insulating or anti-conductive protective coat 65 is formed so that the IDT electrode 63 and the electrode finger mesenteriolum 64 may be covered. The purport which the above-mentioned electrode finger mesenteriolum 64 and a protective coat 65 consist of with anti-conductivity ingredients, such as insulating materials, such as SiO2, and silicone, is indicated by surface acoustic wave equipment 61 given in this advanced technology. Here, it is supposed that degradation of the property by discharge between the electrode fingers which originate in the pyroelectricity which the piezo-electric substrate 61 has by formation of the above-mentioned electrode finger mesenteriolum 63 will be controlled.
[0005]
On the other hand, after forming the electrode which consists of metals, such as aluminum metallurgy, on the piezo-electric substrate which becomes the following patent reference 2 from Xtal or lithium niobate and forming SiO2 film further, 1 port mold surface acoustic wave intermediary resonator which comes to carry out flattening of this SiO2 film is indicated. Here, it is supposed that the good resonance characteristic will be acquired by flattening.
[0006]
[Patent reference 1]
JP,11-186866,A
[Patent reference 2]
JP,6-258355,A
[0007]
[Problem(s) to be Solved by the Invention]
By the manufacture approach of the surface acoustic wave equipment which comes to form membranes SiO2 film in order to improve the conventional frequency temperature characteristic, as shown in drawing 109 , the part in which IDT electrode 53A exists will differ in the height of the front face of SiO2 film 54 from the part not existing. Therefore, there was a problem that an insertion loss deteriorated, by existence of the irregularity of the SiO2 film 54 above-mentioned front face. Moreover, this irregularity becomes large as the thickness of an IDT electrode becomes large. Therefore, thickness of an IDT electrode was not able to be thickened.
[0008]
On the other hand, with surface acoustic wave equipment given in reference 1, after the electrode finger mesenteriolum 64 is formed between the electrode fingers of the IDT electrode 63, the protective coat 65 is formed. Therefore, flattening of the front face of a

protective coat 65 can be carried out.
[0009]
However, the IDT electrode 63 was constituted from a configuration of a publication by reference 1 with the alloy which uses aluminum or aluminum as a principal component. Although the electrode finger mesenteriolum 64 was formed so that this IDT electrode 63 might be touched, sufficient reflection coefficient was not able to be obtained in the IDT electrode 63. Therefore, there was a problem that a ripple tended to arise in the resonance characteristic etc., for example.
[0010]
Furthermore, although the resist which preceded forming a protective coat 65 and was formed on the electrode finger mesenteriolum 64 had to be removed by the manufacture approach given in reference 1 using resist exfoliation liquid, there was a possibility that the IDT electrode 63 might be corroded by resist exfoliation liquid in this case. Therefore, the metal which is easy to be corroded was not able to be used as a metal which constitutes an IDT electrode. That is, the class of IDT electrode configuration metal had constraint.
[0011]
On the other hand, although it is shown by 1 port mold surface acoustic wave resonator given in the patent reference 2 mentioned above using Xtal or lithium niobate as a piezo-electric substrate and that an electrode consists of aluminum or gold, only the example in which the electrode which consists of aluminum was formed on the Xtal substrate is shown by the concrete example. That is, reference is not made especially about the surface acoustic wave equipment using other substrate ingredient or other metallic materials.
[0012]
The purposes of this invention are the surface acoustic wave equipment with which the insulating material layer is formed between the electrode fingers of an IDT electrode, and on the IDT electrode, and its manufacture approach, and its reflection coefficient of an IDT electrode is fully large, and they are in view of the present condition of the conventional technique mentioned above to offer the surface acoustic wave equipment which it is hard to produce degradation of the property by the ripple which appears in the resonance characteristic etc., therefore has the good resonance characteristic and a good filter shape, and its manufacture approach.
[0013]
Other purposes of this invention have little constraint of selection of the metallic material with which the reflection coefficient of an IDT

electrode not only has a good, property large enough, but constitutes an IDT electrode, and are to offer the surface acoustic wave equipment which the bad influence by the corrosion of an IDT electrode cannot produce easily, and its manufacture approach.

[0014]

The reflection coefficient of an IDT electrode is fully large, and it has a good property and the purpose of further others of this invention not only cannot produce degradation of the property by the corrosion of an IDT electrode easily, but is to offer surface acoustic wave equipment with the still better frequency temperature characteristic, and its manufacture approach.

[0015]

[Means for Solving the Problem]

As mentioned above, it is shown by by carrying out flattening of the SiO_2 film by the patent reference 2 that the good resonance characteristic is acquired. Then, as a piezo-electric substrate, using $LiTaO_3$ substrate with a big electromechanical coupling coefficient, others produced 1 port mold surface acoustic wave resonator like the structure of a publication in the patent reference 2, and investigated the property so that invention-in-this-application persons may get the filter of a broadband. That is, the electrode which consists of aluminum was formed on the $LiTaO_3$ substrate, SiO_2 film was formed, and flattening of the front face of this SiO_2 film was carried out. However, after forming SiO_2 film, the property deteriorated greatly and found out that it was not what can be used.

[0016]

if an electromechanical coupling coefficient uses $LiTaO_3$ large substrate and $LiNbO_3$ substrate compared with Xtal, fractional band width will be boiled markedly and will become large. However, when the electrode which consists of aluminum was formed and SiO_2 film was further formed on $LiTaO_3$ substrate as shown in drawing 2 and drawing 3 as a result of invention-in-this-application persons' performing detailed examination, by carrying out flattening of the front face of SiO_2 film showed that a reflection coefficient decreased sharply to about 0.02. In addition, drawing 2 and drawing 3 are drawings showing relation with a reflection coefficient with electrode layer thickness H/lambda of the surface acoustic wave equipment which forms the IDT electrode which consists of aluminum, gold, or platinum by various thickness on the $LiTaO_3$ substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), and comes to form SiO_2 film further. In addition, as the continuous line in drawing 2 and drawing 3 shows the front face of SiO_2 film typically in drawing 2

and drawing 3 , it shows change of the reflection coefficient when having not carried out flattening, and a broken line shows change of the reflection coefficient at the time of carrying out flattening of the front face of SiO2 film.
[0017]
When the electrode which consists of conventional aluminum is used so that clearly from drawing 2 and drawing 3 , by carrying out flattening of the front face of SiO2 film shows that a reflection coefficient decreases sharply to about 0.02 regardless of electrode layer thickness. For this reason, enough stop bands are no longer obtained and it is thought that a sharp ripple arises near the antiresonant frequency.
[0018]
moreover, as for the reflection coefficient, the thing to which electrode layer thickness increases and which it is alike, it takes and is become large is known conventionally. However, when the electrode which consists of aluminum is used so that clearly from drawing 2 and drawing 3 , even if it enlarges thickness of an electrode, when flattening of the front face of SiO2 film is carried out, it turns out that a reflection coefficient does not increase.
[0019]
On the other hand, it turns out that a reflection coefficient becomes large as the thickness of an electrode increases when the electrode which consists of Au or Pt is formed so that clearly from drawing 2 and drawing 3 , and flattening of the surface acoustic wave of SiO2 film is carried out. Invention-in-this-application persons come to make this invention, as a result of examining many things based on such knowledge.
[0020]
At least one IDT electrode which consists of alloys which are formed on the piezoelectric substrate and said piezoelectric substrate, and use the metal or this metal of high density as a principal component rather than aluminum according to invention of the 1st of this application, In the remaining fields except the field in which said at least one IDT electrode is formed It has the 1st insulating material layer which was in said IDT electrode, abbreviation, etc. by carrying out, and was formed in thickness, and the 2nd insulating material layer formed so that said IDT electrode and the 1st insulating material layer might be covered, and the surface acoustic wave equipment with which the consistency of the above-mentioned IDT electrode is made into 1.5 or more times of the consistency of the 1st insulating material layer is offered. In the 1st invention, while the ripple which appears in the resonance characteristic, a filter shape, etc. is moved out of band, a

ripple is oppressed. Therefore, a good property is realizable.
[0021]
At least one IDT electrode which was formed on the piezoelectric substrate and said piezoelectric substrate according to the large aspect of affairs of invention of the 2nd of this application, The protection metal membrane which consists of the metal or alloy which excelled the metal or alloy which is formed on said IDT electrode and constitutes an IDT electrode in corrosion resistance, In the remaining fields except the field in which said at least one IDT electrode is formed Surface acoustic wave equipment equipped with the 1st insulating material layer formed so that the thickness of the sum total of said IDT electrode and protection metal membrane, abbreviation, etc. might be by carrying out and it might have thickness, and the 2nd insulating material layer formed so that said protection metal membrane and the 1st insulating material layer might be covered is offered.
[0022]
On a specific aspect of affairs with the 2nd invention, mean density of the laminated structure which consists of the above-mentioned IDT electrode and a protection metal membrane is made into 1.5 or more times of the consistency of the 1st insulating material layer, and the unnecessary ripple which appears on the resonance characteristic or a filter shape by it is shifted out of band, and resonates.
[0023]
On a specific aspect of affairs with the 1st and the 2nd invention, the above 1st and the 2nd insulating material layer are formed of SiO2, and the frequency temperature characteristic can offer good surface acoustic wave equipment by it.
[0024]
The surface acoustic wave equipment concerning the 1st and 2nd invention is surface acoustic wave equipment using reflection of a surface acoustic wave preferably. You may be surface acoustic wave equipment which it could be limited, but the end-face reflective mold surface acoustic wave equipment using reflection of opposite 2 end face of a piezoelectric substrate could be constituted especially as structure of using reflection of a surface acoustic wave, or prepared the reflector in the surface acoustic wave propagation direction outside of IDT.
[0025]
The surface acoustic wave equipment concerning the 1st and 2nd invention can be used for various surface acoustic wave resonators or a surface acoustic wave filter. Such a surface acoustic wave resonator may be 1 port mold resonator, and you may be 2 port mold resonator, and a surface

acoustic wave filter may be 2 port mold resonator filter, and may be a ladder mold filter or a lattice mold filter.
[0026]
On a specific aspect of affairs with the surface acoustic wave equipment concerning the 1st and 2nd invention, the above-mentioned electrode is an IDT electrode. On the other hand, an IDT electrode may be a tropism electrode, and can reduce an insertion loss by it.
[0027]
Moreover, the above-mentioned electrode may be a reflector.
On a specific aspect of affairs with the surface acoustic wave equipment concerning the 1st and 2nd invention, the above-mentioned electrodes are an IDT electrode and a reflector electrode.
[0028]
On a specific aspect of affairs with the 1st and the 2nd invention, said piezoelectric substrate is $LiTaO_3$ substrate of an Eulerian angle (0**3 degrees, 104 degrees - 140 degrees, 0**3 degrees). When wavelength of Hs and a surface acoustic wave is set to lambda, the sum total thickness of SiO_2 film which the said 1st and 2nd insulating material layer consists of SiO_2, and constitutes the 1st and 2nd insulating material layer When Hs/lambda is made into the range of 0.03-0.45 and sets wavelength of H and a surface acoustic wave to lambda for the thickness of said electrode, let standardization thickness H/lambda of an electrode be the value with which the following formula (1) is filled.
0.005 <= H/lambda <=0.00025xrho2-0.01056xrho+0.16473 (however, rho mean density of an electrode) -- Formula (1)
[0029]
As the metal which constitutes an electrode from the 1st invention as mentioned above,
A metal is used. As such a metal, Au, Ag, Cu, W, Ta, Pt, nickel, or Mo is mentioned.
[0030]
the main metal membrane which consists of the alloys which make these metals or these metals a subject so that it may mention later in this invention, these metals, or an alloy, and the metal membrane of at least one layer which consists of other metals -- ** -- an electrode may be constituted by the cascade screen. In this case, it considers as the specific range, and an electromechanical coupling coefficient and a reflection coefficient can be raised, and standardization thickness Hs/lambda of the sum total of this SiO_2 film at the time of constituting the Eulerian angle [of standardization thickness H/lambda of an electrode and a piezoelectric substrate] and 1st, and 2nd insulating

material layer from SiO2 film according to a metaled class can realize the good frequency temperature characteristic. Moreover, the fall of an attenuation coefficient can also be aimed at by choosing each above-mentioned range.

[0031]

The process which invention of the 3rd of this application is the manufacture approach of the surface acoustic wave equipment concerning the 1st invention, and prepares a piezoelectric substrate, While removing the 1st insulating material layer of the part in which said IDT electrode is formed using the resist pattern for forming the electrode pattern which has the process which forms the 1st insulating material layer all over one side of said piezoelectric substrate, and at least one IDT electrode The process which makes the laminated structure of the 1st insulating material layer and a resist remain to the remaining fields, The process which the electrode layer which consists of an alloy which uses the metal or this metal of high density as a principal component is in the 1st insulating material layer, abbreviation, etc. rather than aluminum by making it the field to which said 1st insulating material layer is removed, forms in thickness, and forms at least one IDT electrode, It is characterized by having the process which removes the resist which remains on said 1st insulating material layer, and the process which forms the 2nd insulating material layer so that a said 1st insulating material layer and IDT electrode top may be covered.

[0032]

Also in the manufacture approach of the surface acoustic wave equipment concerning the 3rd invention, preferably, the consistency of the metal which constitutes the above-mentioned IDT electrode, or an alloy is made into 1.5 or more times of the consistency of the 1st insulating material layer, and the unnecessary ripple which appears on the resonance characteristic or a filter shape is shifted out of band, and it resonates.

[0033]

Invention of the 4th of this application is the manufacture approach of surface acoustic wave equipment, and is for obtaining the surface acoustic wave equipment concerning the 2nd invention. The process for which the 4th invention prepares a piezoelectric substrate, and the process which forms the 1st insulating material layer on the whole surface of one side of said piezoelectric substrate, The process which the 1st insulating material layer of the field of a part in which said electrode is formed using the resist pattern for forming at least one IDT electrode pattern is removed [process], and makes the laminated

structure of the 1st insulating material layer and a resist remain to the remaining fields, The metal or alloy film for forming an IDT electrode in the field to which said 1st insulating material layer is removed is formed. The process which forms an IDT electrode, and after forming said IDT electrode The process which forms the protection metal membrane which consists of a metal or an alloy excellent in corrosion resistance all over this IDT electrode, and said protection metal membrane is in the height of said 1st insulating material layer, abbreviation, etc. by carrying out, and forms it in height rather than the metal or alloy which constitutes this IDT electrode, It is characterized by having the process which removes the protection metal membrane by which the laminating is carried out on the resist on said 1st insulating material layer, and this resist, and the process which forms the 2nd insulating material layer so that the protection metal membrane formed on said IDT electrode and said 1st insulating material layer may be covered.

[0034]

Also in the 4th invention, like the 2nd invention, preferably, mean density of the laminated structure which consists of an IDT electrode and a protection metal membrane is made into 1.5 or more times of the consistency of the 1st insulating material layer, and the unnecessary ripple which appears on the resonance characteristic or a filter shape is shifted out of band, and it resonates.

[0035]

Invention of the 5th of this application is the manufacture approach of surface acoustic wave equipment equipped with the process which carries out flattening of the irregularity of the insulating material layer above the process which prepares a piezoelectric substrate, the process which forms an electrode on said piezoelectric substrate, the process which forms an insulating material layer so that said electrode may be covered, the part in which said electrode exists, and the part not existing.

[0036]

In the 5th invention, the above-mentioned flattening process is preferably performed by etchback, a reverse spatter, or polish.

[0037]

[Embodiment of the Invention]

Hereafter, this invention is clarified by explaining the concrete example of this invention, referring to a drawing.

[0038]

With reference to drawing 1 and drawing 6 , the manufacture approach of

the surface acoustic wave equipment concerning the 1st example of this invention is explained.
As shown in drawing 1 (a), $LiTaO_3$ substrate 1 is first prepared as a piezoelectric substrate. At this example, $LiTaO_3$ substrate of (0 degree, 126 degrees, 0 degree) is used by 36-degree Y cut X propagation and the Eulerian angle. But what may use $LiTaO_3$ substrate of other crystal orientation, or consists of other piezo-electric single crystals as a piezoelectric substrate may be used. Moreover, the piezoelectric substrate which comes to carry out the laminating of the piezoelectric thin film may be used on an insulating substrate. In addition, there is relation of +90 degrees of theta= cut angles of an Eulerian angle (phi, theta, psi).
[0039]
On $LiTaO_3$ substrate 1, the 1st insulating material layer 2 is formed on the whole surface. In this example, the 1st insulating material layer 2 is formed with SiO_2 film.
The formation approach of the 1st insulating material layer 2 may be performed by proper approaches, such as printing, vacuum evaporationo, or sputtering. Moreover, thickness of the 1st insulating material layer 2 is made equal to the thickness of the IDT electrode formed later.
[0040]
Next, as shown in drawing 1 (b), a resist pattern 3 is formed using a photolithography technique. The resist pattern 3 consists of resist patterns 3 so that a resist may be located except for the field in which IDT is formed.
[0041]
Next, the remaining part except the part located under the resist 3 among the 1st insulating material layers 2 is removed by the reactive-ion-etching method (RIE) which irradiates an ion beam at drawing 1 (c) as an arrow head shows.
[0042]
When SiO_2 is etched by RIE by the gas of a fluorine system, residue may arise by the polymerization reaction. In this case, after performing RIE, it can respond by processing by BHF (buffered fluoric acid) etc.
[0043]
After an appropriate time, Cu film and Ti film are formed in thickness equal to the 1st insulating material layer 2. As shown in drawing 1 (d), the Cu film 4 is given to the field where the 1st insulating material layer 2 is removed, i.e., the field in which IDT is formed, and the Cu film 4 is given to coincidence also on a resist pattern 3. Next, the Ti film 5 is formed as a complete protection metal membrane. As shown in

drawing 1 (e), the Ti film 5 will be given on the top face of IDT electrode 4A, and the Cu film 4 on a resist pattern 3. Therefore, a side face is covered with the 1st insulating material layer 2, and, as for IDT electrode 4A, the top face is covered with the Ti film 5. Thus, IDT electrode 4A and a protection metal membrane are formed, and it is constituted so that the thickness of IDT electrode 4A, the thickness of the sum total of the thickness of the Ti film 5 as a protection metal membrane, and the thickness of the 1st insulating material layer 2 may have the same thickness.
[0044]
After an appropriate time, a resist pattern 3 is removed using resist exfoliation liquid. Thus, as shown in drawing 1 R> 1 (f), IDT electrode 4A is formed in the remaining fields except the field in which the 1st insulating material layer 2 is formed, and the structure where the top face of IDT electrode 4A is covered with the Ti film 5 is acquired.
[0045]
As shown in drawing 1 (g) after an appropriate time, SiO2 film is formed in the whole surface as the 2nd insulating material layer 6.
Thus, the surface acoustic wave resonator 11 of 1 port mold shown in drawing 6 was obtained.
[0046]
In addition, only the part in which IDT electrode 4A is formed was extracted and explained by drawing 1 (a) - (g). However, the surface acoustic wave resonator 11 equips the surface acoustic wave propagation direction both sides of IDT electrode 4A with reflectors 12 and 13 as shown in drawing 6 . Reflectors 12 and 13 are also formed of the same process as IDT electrode 4A.
[0047]
Although one IDT electrode 4A was formed on LiTaO3 substrate 1 in the above-mentioned example since 1 port mold surface acoustic wave resonator 11 was constituted, according to the application of surface acoustic wave equipment, two or more IDT electrodes may be formed, and a reflector may be formed of the same process as IDT as mentioned above, and a reflector is not prepared, but ** is also good.
[0048]
For the comparison, 1 port mold surface acoustic wave resonator was produced according to the manufacture approach of surface acoustic wave equipment of having SiO2 conventional film shown in drawing 109 . But also in this example of a comparison, the IDT electrode was formed by Cu, using LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle) as a

substrate ingredient. Since SiO2 film 54 was formed after IDT electrode 53A is formed so that clearly from the manufacture approach shown in drawing 109 , irregularity could not but arise on the front face of SiO2 film 54. In the example of a comparison, the impedance characteristic and phase characteristic at the time of setting to 0.042 standardization thickness h/lambda (h being the thickness of an IDT electrode and lambda being the wavelength of a surface acoustic wave) of the IDT electrode which consists of Cu, and carrying out standardization thickness Hs/lambda (Hs being the thickness of SiO2 film) of SiO2 film to 0.11, and 0.22 and 0.33 are shown in drawing 4 . It turns out that the impedance ratio which is a ratio of the impedance in an antiresonance point and the impedance in the resonance point becomes small as standardization thickness Hs/lambda of SiO2 film becomes large so that clearly from drawing 4 .
[0049]
Moreover, drawing 5 shows the relation between standardization thickness Hs/lambda of SiO2 film of a surface acoustic wave resonator manufactured in the example of a comparison, and MF (Figure of Merit) of a resonator. It turns out that MF falls as the thickness of SiO2 film becomes thick so that clearly from drawing 5 .
[0050]
That is, the property deteriorated greatly as the thickness of SiO2 film became thick even if it formed the IDT electrode by Cu when an IDT electrode and SiO2 film were formed according to the conventional method shown in drawing 109 . This is considered to be because for the irregularity mentioned above on the SiO2 film front face to arise.
[0051]
On the other hand, according to the manufacture approach of this example, even when the thickness of SiO2 film is made to increase, it is shown in that it is hard to produce degradation of a property, and drawing 7 -9. Drawing 7 is the change **** Fig. of the impedance characteristic at the time of changing the thickness of SiO2 film at the time of obtaining the surface acoustic wave resonator 11 according to the above-mentioned example, i.e., the thickness of the 2nd insulating material layer 6, and a phase characteristic. Moreover, the broken line of drawing 8 and drawing 9 is drawing showing change of the resonator at the time of changing thickness Hs/lambda of SiO2 film in an example of gamma and MF, respectively.
[0052]
In addition, in drawing 8 and drawing 9 , a continuous line shows the result of the above-mentioned example of a comparison.

If drawing 7 is compared with drawing 4 , even if it makes standardization thickness Hs/lambda of SiO2 film increase compared with the case of the example of a comparison, in the above-mentioned example, it turns out that it is hard to produce the fall of an impedance, so that clearly.
[0053]
Moreover, according to the manufacture approach of an example, compared with the example of a comparison, it turns out that degradation of the property accompanying the increment in standardization thickness Hs/lambda of SiO2 film is controlled so that clearly from the result of drawing 8 and drawing 9 .
[0054]
That is, according to the manufacture approach of this example, even if it is the case where the thickness of SiO2 film is made to increase as mentioned above, it is hard to produce the fall of an impedance ratio, and degradation of a property can be controlled.
[0055]
On the other hand, drawing 10 is drawing showing the relation between the thickness of SiO2 film, and the frequency temperature characteristic TCF of the surface acoustic wave resonator obtained by the manufacture approach of the example of a comparison, and an example.
In drawing 10 , a continuous line shows the example of a comparison and a broken line shows the result of an example.
[0056]
When the thickness of SiO2 film is made to increase so that clearly from drawing 10 according to the manufacture approach of an example, it turns out that the frequency temperature characteristic TCF can be ideally improved according to the increase of thickness.
[0057]
Therefore, by adopting the manufacture approach of the above-mentioned example shows that it is hard to produce degradation of a property and the surface acoustic wave resonator which can improve the temperature characteristic effectively can be offered.
In addition, by the manufacture approach of this example, the IDT electrode is constituted from aluminum by Cu of high density. Therefore, IDT electrode 4A has sufficient reflection coefficient, and can control the ripple which is not the request which appears on the resonance characteristic. This is explained below.
[0058]
If it removed having replaced with Cu and having used aluminum film, the surface acoustic wave resonator of the 2nd example of a comparison was

produced like the above-mentioned example. However, standardization thickness Hs/lambda of SiO2 film was set to 0.08. That is, standardization thickness of the thickness of the 1st insulating material layer was set to 0.08. Thus, a continuous line shows the impedance and phase characteristic of a surface acoustic wave resonator which were acquired to drawing 11 .

[0059]

Moreover, if it removes having not formed SiO2 film, a broken line shows the impedance and phase characteristic of a surface acoustic wave resonator which were constituted like the 2nd example of a comparison to drawing 11 .

[0060]

When an IDT electrode is formed with aluminum and SiO2 film is formed even if it follows the manufacture approach of the above-mentioned example so that clearly from the continuous line of drawing 11 , it turns out that the big ripple shown by the arrow head A of drawing 11 appears between the resonance point and an antiresonance point. Moreover, it turns out that such a ripple does not appear in the surface acoustic wave resonator which does not have SiO2.

[0061]

Therefore, even if it is going to aim at an improvement of the frequency temperature characteristic etc. by formation of SiO2 film, when an IDT electrode is formed by aluminum, it turns out that the above-mentioned ripple A appears and degradation of a property is caused. As a result of inquiring to a pan per this point, when using the metal of high density rather than aluminum as an IDT electrode, the invention-in-this-application person could raise the reflection coefficient of an IDT electrode, and found out that the above-mentioned ripple A could be controlled by it.

[0062]

That is, according to the same manufacture approach as the above-mentioned example, various consistencies of the metal which constitutes the IDT electrode 4 were changed, and the surface acoustic wave resonator was produced like the above-mentioned example. Thus, the impedance characteristic of the obtained surface acoustic wave resonator is shown in drawing 12 (a) - (e). Drawing 1212 (a) The ratios [respectively as opposed to the consistency rho 2 of the 1st insulating material layer of the mean density rho 1 of the laminated structure of an IDT electrode and a protection metal membrane in - (e)] rho1/rho2 show the result in 2.5, 2.0, 1.5, 1.2, and 1.0.

[0063]

Drawing 12 (a) At drawing 12 (a) - (c), the above-mentioned ripple A is shifted out of band, and it turns out further by drawing 12 (a) that the above-mentioned ripple A is oppressed remarkably so that clearly from - (e).

[0064]

Therefore, the result of drawing 12 shows that shift 1.5 or more times, then the above-mentioned ripple A to the outside of the band of resonance frequency-antiresonant frequency, and a good property is acquired in the density ratio to the 1st insulating material layer of the laminated structure of an IDT electrode and a protection metal membrane. Moreover, it turns out more preferably that 2.5 or more times, then the ripple itself can be made small for the above-mentioned density ratio.

[0065]

Drawing 12 (a) Although the above-mentioned mean density was used in - (e) since the laminating of the Ti film was carried out on IDT electrode 4A according to the above-mentioned example, in this invention, a protection metal membrane is not prepared on IDT electrode 4A, but ** is also good. In that case, it was desirable to have made thickness of IDT electrode 4A the same as the thickness of the 1st insulating material layer, and to have made the ratio to the consistency of the 1st insulating material layer of the consistency of an IDT electrode into 1.5 or more times, more preferably, it was good and it was confirmed 2.5 or more times, then that the same effectiveness as the above is acquired.

[0066]

Therefore, in the surface acoustic wave resonator which comes to cover an IDT electrode with SiO2 film, if the consistency of an IDT electrode or mean density of the layered product of an IDT electrode and a protection metal membrane is made larger than the consistency of the 1st insulating material layer located in the side of an IDT electrode, it turns out that the reflection coefficient of an IDT electrode can be raised and degradation of the property which appears between resonance point-antiresonance points by it can be controlled.

[0067]

In addition, as the metal or alloy of high density, the alloy which makes others, Ag, Au, etc. and these a subject is mentioned from aluminum. [Cu]

Moreover, since the side face of IDT electrode 4A is covered with the 1st insulating material layer 2 and the top face is covered with the protection metal membrane 6 on the IDT electrode like [it is desirable and] the above-mentioned example in case a resist pattern 3 is

exfoliated so that clearly from the structure which carried out the laminating of the protection metal membrane, then the manufacture approach which showed drawing 1 (a) - (g), the corrosion of IDT electrode 4A can be prevented. Therefore, it turns out that the surface acoustic wave resonator which has a much more good property can be offered.

[0068]

Furthermore, the 1st and 2nd insulating material layer may be formed with an insulating ingredient with other temperature characteristic improvement effects, such as SiOxN(ies) other than SiO2. Moreover, the 1st and 2nd insulating material layer may consist of different insulating ingredients, and may consist of ingredients equal as mentioned above.

[0069]

Drawing 13 is drawing showing the relation of an electromechanical coupling coefficient with standardization thickness H/lambda of IDT at the time of forming an IDT electrode using various metals by various thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree).

[0070]

When the standardization thickness of the electrode with which an electromechanical coupling coefficient becomes large compared with aluminum obtained from drawing 13 was investigated about each metal, the result shown in drawing 14 was obtained. That is, drawing 14 is drawing showing the electrode layer Atsunori enclosure where an electromechanical coupling coefficient becomes large compared with the case where the IDT electrode which consists of aluminum as mentioned above is formed, when the IDT electrode which consists of a metal of various consistencies is formed on the above-mentioned LiTaO3 substrate.

[0071]

In drawing 14 , among the thickness range of the electrode which consists of each metal, an electromechanical coupling coefficient is the threshold value of the range which becomes large, and, as for the minimum of the electrode layer Atsunori enclosure of each metal, an upper limit shows a production limitation rather than aluminum. It will be set to y=0.00025 x2-0.01056x+0.16473 if an upper limit is approximated by the quadratic, using a consistency as x using the range of electrode layer thickness with a big electromechanical coupling coefficient as y.

[0072]

Therefore, the electrode is formed on the piezo-electric substrate which

consists of $LiTaO_3$ of 14 degrees - 50 degree rotation Y cut X propagation (they are (0 degree, 104 degrees - 140 degrees, 0 degree) at an Eulerian angle), and standardization thickness H/lambda of an electrode further SiO_2 film in the structure currently formed in the range of standardization thickness Hs/lambda 0.03-0.45 so that clearly from explanation of the concrete example according to each below-mentioned electrode material,

$0.005 \le H/\lambda \le 0.00025 \times \rho^2 - 0.01056 \times \rho + 0.16473$ -- Formula (1)

A ******* case, an electromechanical coupling coefficient can be raised so that clearly from the result of drawing 14 . In addition, rho shows the mean density of an electrode.

[0073]

In this invention, an electrode is characterized by consisting of aluminum mentioned above using a metal with a high consistency. In this case, the electrode may consist of alloys which may consist of metals with a consistency higher than aluminum, or make aluminum a subject. moreover, it consists of a different metal from the main metal membrane which consists of an alloy which uses aluminum or aluminum as a principal component, and this metal membrane -- ** -- you may consist of laminated structures of a metal membrane. When the electrode is constituted by the cascade screen and the consistency of the metal of rho and a main electrode layer is set to rho 0 for the mean density of an electrode, what is necessary is just the mean density which satisfies $\rho_0 \times 0.7 \le \rho \le \rho_0 \times 1.3$.

[0074]

Moreover, in this invention, although flattening of the front face of the 2nd insulating material layer is carried out as mentioned above, this flattening should just have 30% or less of irregularity of the thickness of an electrode. If it exceeds 30%, the effectiveness by flattening may not fully be acquired.

[0075]

Furthermore, flattening of the 2nd insulating material layer is performed by various approaches as mentioned above. For example, the flattening approach by etchback, the flattening approach using the oblique incidence effectiveness by the reverse spatter effectiveness, the approach of grinding an insulating material layer front face, or the approach of grinding an electrode is mentioned. As for these approaches, two or more sorts may be used together. Drawing 102 - Fig. 105 is explained for the detail of these approaches.

[0076]

Drawing 102 (a) - (c) is the approach of carrying out flattening of the

insulating material layer front face by the etchback approach. First, as shown in drawing 102 (a), on the piezoelectric substrate 41, an electrode 42 is formed and the insulating material layer 43 is formed after an appropriate time. As shown in drawing 102 (b), a resist 44 is formed of spin coating etc. on the insulating material layer 43. The front face of a resist 44 is flat. Therefore, flattening of the front face of the insulating material layer 43 which consists of SiO2 etc. can be carried out by etching by reactive ion etching, i.e., etchback, from this condition (drawing 102 (c)).
[0077]
Drawing 103 (a) - (d) is each typical sectional view for explaining a reverse spatter. Here, an electrode 42 is formed on the piezoelectric substrate 41, and the insulating material layer 43 is formed after an appropriate time. And argon ion etc. is irradiated on the front face of the insulating material layer 43 by sputtering. This ion is used in order to carry out the spatter of the substrate 41. When ion collides with a substrate and performs sputtering, the spatter effectiveness that the direction in the case of carrying out incidence to a slanting field is big is acquired rather than it carries out incidence to a flat field. This is known as oblique incidence effectiveness. Flattening of it is carried out by this effectiveness as are shown in drawing 103 (b) - (d) and the front face of the insulating material layer 43 advances sputtering.
[0078]
Drawing 104 (a) and (b) are the typical sectional views for explaining how carrying out flattening by grinding an insulating material layer. As shown in drawing 104 (a), after forming an electrode 42 and the insulating material layer 43 on a substrate 41, flattening of the front face of the insulating material layer 43 can be carried out by grinding mechanically or chemically.
[0079]
Drawing 105 (a) - (c) is the approach of attaining flattening, by grinding an electrode. Here, as shown in drawing 105 (a), after forming the 1st insulating material layer 45 on a substrate 41, vacuum evaporationo etc. forms in the whole surface metal membrane 42A which consists of an electrode material. As shown in drawing 105 (b) after an appropriate time, the 1st insulating material layer 45 formed in the field around the field in which the electrode 42 and the electrode 42 are formed is formed by grinding metal membrane 42A mechanically or chemically. Thus, the 1st insulating material layer 45 and the top face of an electrode 42 are made flat-tapped, and flattening is carried out.

As shown in drawing 105 (c) after an appropriate time, an insulating material layer with a flat front face can be formed by forming the 2nd insulating material 46.
[0080]
This invention is applicable to various surface acoustic wave equipments. The example of such surface acoustic wave equipment is shown in drawing 106 (a), (b) - Fig. 108 . Drawing 106 (a) and (b) are the typical top views showing the electrode structure of 1 port mold surface acoustic wave resonator 47 and 2 port mold surface acoustic wave resonator 48, respectively. Moreover, 2 port mold surface acoustic wave resonator filter may be constituted using the same electrode structure as 2 port mold surface acoustic wave resonator 48 shown in drawing 106 (b).
[0081]
Furthermore, Fig. 107 and 108 is a typical top view showing the electrode structure of a ladder mold filter and a lattice mold filter, respectively. By forming electrode structure like ladder mold filter 49a shown in Fig. 107 and 108 , and lattice mold filter 49b on a piezoelectric substrate, a ladder mold filter and a lattice mold filter can be constituted according to this invention.
[0082]
But this invention is applicable not only to the surface acoustic wave equipment which has the electrode structure shown in Fig. 106 and 107 but various surface acoustic wave equipments.
Moreover, the surface acoustic wave equipment using a leakage elastic wave consists of preferably surface acoustic wave equipment concerning this invention. It is surface acoustic wave equipment which has the electrode which becomes JP,6-164306,A from heavy metals, such as Au, and the surface acoustic wave equipment using a Love wave without propagation attenuation is indicated. Here, by using a heavy metal as an electrode, acoustic velocity of the surface acoustic wave to spread is made later than a transverse-wave bulk wave with a late substrate, a leakage component is lost and the Love wave as a non-revealing surface acoustic wave is used by it.
[0083]
However, in the above-mentioned Love wave, acoustic velocity cannot but become slow inevitably and the pitch of IDT cannot but become small in connection with it. Therefore, the difficulty of processing becomes high and process tolerance deteriorates. In addition, the line breadth of IDT also becomes small and loss by resistance also increases. Therefore, loss cannot but become large.
[0084]

On the other hand, in this invention, in spite of using the electrode which consists of a metal heavier than aluminum unlike the surface acoustic wave equipment which used the above Love waves, the quick leakage surface acoustic wave of acoustic velocity can be used suitably, and even if it is that case, reduction of a propagation loss can be aimed at. Therefore, the surface acoustic wave equipment of low loss can be constituted.

[0085]

Hereafter, suppose that it explains for every metallic material about each example when a metal with a large consistency constitutes an electrode from aluminum based on the result mentioned above.

With in addition, a metal with a larger consistency than aluminum used by this invention (1) The metal a consistency 15000 - 23000 kg/m3 and Young's modulus 0.5x1011 - 1.0x1011 N/m2, or whose transverse-wave acoustic velocity is 1000 - 2000 m/s, For example, the metal Au, the (2) consistency 5000 - 15000 kg/m3 and Young's modulus 0.5x1011 - 1.0x1011 N/m2, or whose transverse-wave acoustic velocity is 1000 - 2000 m/s, For example, the metal Ag, the (3) consistency 5000 - 15000 kg/m3 and Young's modulus 1.0x1011 - 2.05x1011 N/m2, or whose transverse-wave acoustic velocity is 2000 - 2800 m/s, For example, the metal Cu, the (4) consistency 15000 - 23000 kg/m3 and Young's modulus 2.0x1011 - 4.5x1011 N/m2, or whose transverse-wave acoustic velocity is 2800 - 3500 m/s, For example, the metal a tungsten, the (5) consistency 15000 - 23000 kg/m3 and Young's modulus 1.0x1011 - 2.0x1011 N/m2, or whose transverse-wave acoustic velocity is 2000 - 2800 m/s, For example, the metal a tantalum, the (6) consistency 15000 - 23000 kg/m3 and Young's modulus 1.0x1011 - 2.0x1011 N/m2, or whose transverse-wave acoustic velocity is 1000 - 2000 m/s, For example, the metal platinum, the (7) consistency 5000 - 15000 kg/m3 and Young's modulus 2.0x1011 - 4.5x1011 N/m2, or whose transverse-wave acoustic velocity is 2800 - 3500 m/s, for example, nickel and Mo, is mentioned.

[0086]

[The example to which an electrode makes Au a subject]

Drawing 15 is a top view for explaining the vertical joint resonator filter as surface acoustic wave equipment concerning other examples of this invention.

[0087]

Surface acoustic wave equipment 21 has the structure in which IDT(s) 23a and 23b and Reflectors 24a and 24b were formed on the top face of LiTaO3 substrate 22. Moreover, SiO2 film 15 is formed so that IDT(s) 23a and 23b and Reflectors 24a and 24b may be covered. In addition, as LiTaO3

substrate 22, 25 degrees - 58 degree rotation Y cut X propagation (Eulerian angle (0-degree, 115 degrees - 148 degree, 0 degree)) LiTaO3 substrate is used. In this rotation Y cut X propagation LiTaO3 substrate of a cut angle out of range, an attenuation coefficient is large and TCF also gets worse.

[0088]

IDT(s) 23a and 23b and Reflectors 24a and 24b are constituted by the metal with a high consistency compared with aluminum. Even if at least one sort of metals chosen from the group which consists of Au, Pt, W, Ta, Ag, Mo, Cu, nickel, Co, Cr, Fe, Mn, Zn, and Ti as such a metal, or this ** is not, the alloy which uses one of them as a principal component is mentioned.

[0089]

As mentioned above, since IDT(s) 23a and 23b and Reflectors 24a and 24b are constituted by the metal with a high consistency compared with aluminum, even if it is the case where thickness of IDT(s) 23a and 23b and Reflectors 24a and 24b is made thin compared with the case where aluminum is used, as shown in drawing 16 and drawing 17 , an electromechanical coupling coefficient and a reflection coefficient can be raised.

[0090]

And electrode layer thickness can be made thin as mentioned above. About the thickness of SiO2 film 25, it is desirable that the range of thickness Hs/lambda standardized on the wavelength of a surface acoustic wave is 0.03-0.45 so that clearly from the below-mentioned example of an experiment. In addition, the thickness of the sum total when Hs constitutes the 1st and 2nd insulating material layer from SiO2, and lambda show the wavelength of a surface acoustic wave. By making it this range, an attenuation coefficient can be sharply made small and low loss-ization is attained from the case where there is no SiO2 film.

[0091]

Although it changes also with ingredients which constitute IDT, when consisting of Au film, for example, as for the thickness standardized on the wavelength of the surface acoustic wave of IDT(s) 23a and 23b, 0.013-0.030 are desirable. Since IDT lengthens and it has surroundings resistance when Au film is thin, 0.021-0.03 are more preferably desirable.

[0092]

With the surface acoustic wave equipment which this invention requires, as mentioned above, IDT(s) 23a and 23b are constituted from aluminum on LiTaO3 substrate 22 by the metal with a large consistency, and this

electrode layer thickness of IDT(s) 23a and 23b can be made thin. Therefore, it has a good property and the good frequency temperature characteristic is realized by formation of SiO2 film 25. This is explained based on a concrete example.
[0093]
When IDT which consists of aluminum is formed on the LiTaO3 substrate of (0 degree, 126 degrees, 0 degree) by 36-degree rotation Y cut X propagation and the Eulerian angle, change of the electromechanical coupling coefficient Ksaw at the time of forming by the various thickness of IDT which consists of Au, Ta, Ag, Cr, W, Cu, Zn, Mo, and nickel and an attenuation coefficient (alpha), and reflection coefficient |ref| is shown in drawing 16 , drawing 18 , and drawing 17 , respectively. in addition, numerical calculation -- the approach of J.J.Champbell and W.R.Jones:IEEE Trans.Sonic&Ultrason.SU-15.p209 (1968) -- following -- an electrode -- the whole surface -- it calculated as uniform.
[0094]
When standardized thickness H/lambda is 0.10 in IDT which consists of aluminum so that clearly from drawing 16 , an electromechanical coupling coefficient Ksaw is about 0.27. In addition, H shows thickness and lambda shows the wavelength of a surface acoustic wave. On the other hand, in IDT which consists of Au, Ta, Ag, Cr, W, Cu, Zn, Mo, and nickel, when H/lambda is made into the range of 0.013-0.035, the bigger electromechanical coupling coefficient Ksaw can be realized. However, by IDT which consists of Au, Ta, Ag, Cr, W, Cu, Zn, Mo, and nickel, an attenuation coefficient becomes very large to an attenuation coefficient alpha being about 0 regardless of thickness H/lambda at IDT which consists of aluminum so that clearly from drawing 18 .
[0095]
Drawing 25 is drawing in the structure which formed IDT and SiO2 film which consists of Au on the LiTaO3 substrate of (0 degree, theta, 0 degree) by the Eulerian angle showing relation with an electromechanical coupling coefficient with theta. Here, when standardization thickness of IDT which consists of Au was set to 0.022, 0.025, and 0.030, standardization thickness Hs/lambda of SiO2 film was changed to the list with 0.00 (SiO2 film is not formed), 0.10, 0.20, and 0.30 and 0.45.
[0096]
It turns out that SiO2 film takes for becoming thick and an electromechanical coupling coefficient Ksaw becomes small so that clearly from drawing 25 . Moreover, in order to control degradation of the property by SiO2 film so that it may mention later, the case where

thickness of IDT is made thin is considered. Even when standardization thickness is made thin to 0.04 in IDT which consists of conventional aluminum so that clearly from above-mentioned drawing 16 and SiO2 film is not formed, an electromechanical coupling coefficient Ksaw becomes small with 0.245. Moreover, when standardization thickness of IDT which consists of aluminum is set to 0.04 and SiO2 film is formed, an electromechanical coupling coefficient Ksaw becomes still smaller, and broadband-ization becomes difficult practically.
[0097]
On the other hand, with the structure which formed IDT which consists of Au and formed SiO2 film, even if it is the case where standardization thickness Hs/lambda of SiO2 film is made about into 0.45 by making theta of an Eulerian angle into 128.5 degrees or less, it turns out that an electromechanical coupling coefficient Ksaw becomes 0.245 or more, so that clearly from drawing 25 . Moreover, when standardization thickness forms SiO2 film which is about 0.30, an electromechanical coupling coefficient Ksaw can be made or more into 0.245 by making theta of an Eulerian angle into 132 degrees or less. In addition, when smaller than 115 degrees, an attenuation coefficient becomes large and theta of an Eulerian angle is not practical, so that it may mention later. Therefore, it turns out that it is suitable 25 degrees - 42 degree rotation Y cut X propagation (being an Eulerian angle (0**3 degrees, 115 degrees - 132 degrees, 0**3 degrees)) and to use LiTaO3 substrate of 25 degrees - 38.5 degree rotation Y cut X propagation (being an Eulerian angle (0**3 degrees, 115 degrees - 128.5 degrees, 0**3 degrees)) more preferably.
[0098]
On the other hand, the frequency temperature characteristic (TCF) of LiTaO3 substrate of (0 degree, 126 degrees, 0 degree) is -30--40ppm/degree C, and 36-degree rotation Y cut X propagation and an Eulerian angle are not enough as it. In order to improve this frequency temperature characteristic TCF so that it may become within the limits of **20ppm/degree C, 36-degree rotation Y cut X propagation and an Eulerian angle show change of the frequency temperature characteristic at the time of forming IDT which consists of Au and forming SiO2 film by various thickness further on the LiTaO3 substrate of (0 degree, 126 degrees, 0 degree), to drawing 19 . In addition, in drawing 19 , 0 shows a theoretical value and x shows an experimental value. Here, the standardization thickness of IDT which consists of Au is H/lambda =0.020.
[0099]
Formation of SiO2 film shows that the frequency temperature characteristic is improved so that clearly from drawing 19 . When

thickness Hs/lambda by which SiO2 film was standardized especially is near 0.25, TCF is set to 0 and it turns out that it is desirable.
[0100]
Moreover, numerical analysis of the change of the attenuation coefficient alpha at the time of changing various thickness of IDT which a cut angle becomes from Au, using LiTaO3 substrate of two kinds of Eulerian angles, 36 degrees (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle) and 38 degrees (they are (0 degree, 128 degrees, 0 degree) at an Eulerian angle), as rotation Y cut X propagation LiTaO3 substrate, and thickness of SiO2 film was carried out. A result is shown in drawing 20 and drawing 21 . In addition, drawing 20 and the thickness value of Au of drawing 21 are H/lambda. If the thickness of SiO2 film is chosen regardless of the thickness of IDT which consists of Au so that clearly from drawing 20 and drawing 21 , it turns out that an attenuation coefficient alpha can be made small. That is, it turns out that an attenuation coefficient alpha may be made very small in thickness Hs/lambda of SiO2 film when 0.03 to 0.45 and IDT which consists of Au of the range of 0.10-0.35 then LiTaO3 substrate of one of Eulerian angles, and which thickness more preferably are formed so that clearly from drawing 20 and drawing 21 .
[0101]
Furthermore, thin thickness is also known by that the sufficiently big reflection coefficient is obtained compared with aluminum when IDT which consists of Au is used by drawing 17 .
Therefore, when thickness H/lambda forms IDT which consists of Au of 0.013-0.030 on LiTaO3 substrate from the result of above-mentioned drawing 16 - drawing 21 , it can make an attenuation coefficient alpha very small, and the range, then the big electromechanical coupling coefficient of 0.03-0.45 are not only obtained in thickness Hs/lambda of SiO2 film, but can obtain sufficient reflection coefficient.
[0102]
In the example mentioned above, a broken line shows the magnitude-of-attenuation-frequency characteristics of the surface acoustic wave equipment 11 of the example which forms IDT which consists of Au of the standardization thickness of H/lambda =0.020 on the LiTaO3 substrate of 36 degrees of cut angles (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle), and comes to form SiO2 film of standardization thickness Hs/lambda =0.1 further to drawing 22 . Moreover, a continuous line shows the magnitude-of-attenuation frequency characteristics of the structure before forming SiO2 film in this surface acoustic wave filter for a comparison.

[0103]
Although an electromechanical coupling coefficient becomes small a little from 0.30 by formation of SiO2 film 0.28 so that clearly from drawing 22 , it turns out that the insertion loss is improved. Therefore, it is proved that the thickness, then the attenuation coefficient alpha of the range of the above-mentioned specification become small about SiO2 film so that clearly from drawing 22 .
[0104]
Based on the knowledge mentioned above, the invention-in-this-application person formed IDT which consists of Au whose standardization thickness is 0.02, formed SiO2 film of still more various thickness on the rotation Y cut X propagation LiTaO3 substrate of various Eulerian angles, and made 1 port mold surface acoustic wave resonator as an experiment. In this case, standardization thickness of SiO2 film was set to 0.10, 0.20, and 0.30 and 0.45. Thus, the Q value of the obtained one port each mold surface acoustic wave resonator was measured. A result is shown in drawing 26 .
[0105]
Generally, the steepness of the filter shape which lasts to a decay area from the passband at the time of using as a filter is raised, so that the Q value of a resonator is large. Therefore, when a steep filter is needed, the larger one of Q value is desirable. Regardless of the thickness of SiO2 film, Q value serves as [a cut angle] max near (0 degree, 138 degrees, 0 degree) by 48-degree rotation Y cut and the Eulerian angle, and it turns out that Q value is comparatively large in the range of 42 degrees - 58 degrees of cut angles (they are (0 degree, 132 degrees - 148 degrees, 0 degree) at an Eulerian angle) so that clearly from drawing 26 .
[0106]
Therefore, LiTaO3 substrate of 42 degrees - 58 degree rotation Y cut (they are (0 degree, 132 degrees - 148 degrees, 0 degree) at an Eulerian angle) of cut angles is used so that clearly from drawing 26 . By forming at least one IDT which consists of metals with a consistency higher than Au on this LiTaO3 substrate, and making SiO2 film into the structure formed on the LiTaO3 substrate so that IDT might be covered further shows that big Q value can be obtained. Preferably, let a cut angle be 46.5 degrees - 53 degree rotation Y cut (for them to be (0 degree, 136.5 degrees - 143 degrees, 0 degree) at an Eulerian angle) so that clearly from drawing 26 .
[0107]
In addition, an adhesion layer may be formed in the top face of IDT in

this invention. That is, as shown in drawing 27 (a), IDT33 is formed on LiTaO3 substrate 32, and the adhesion layer 34 may be produced by the top face of IDT33. The adhesion layer 34 is arranged between IDT33 and SiO2 film 35. The adhesion layer 34 is formed in order to raise the adhesion reinforcement to IDT33 of SiO2 film 35. As an ingredient which constitutes such an adhesion layer 34, Pd, aluminum, or these alloys are used suitably. Moreover, the adhesion layer 34 may be constituted using other ceramics, such as not only a metal but piezoelectric material, such as ZnO, and Ta 2O3 or aluminum 2O3. Rather than aluminum, the adhesion reinforcement of the IDT33 and SiO2 film 35 with which a consistency consists of a high metal is raised by formation of the adhesion layer 34, and film peeling of SiO2 film is controlled by it.
[0108]
In order not to have effect on a surface acoustic wave at large, as for the thickness of the adhesion layer 34, it is desirable to consider as about 1% or less of thickness of the wavelength of a surface acoustic wave. Moreover, in drawing 27 (a), although the adhesion layer 34 was formed in the top face of IDT33, as shown in drawing 27 (b), adhesion layer 34A may be formed on LiTaO3 substrate also at an interface with SiO2 film 35. As furthermore shown in drawing 27 (c), the adhesion layer 34 may be formed so that not only the top face of IDT33 but a side face may be covered.
[0109]
Moreover, as other configurations which improve the adhesion reinforcement of SiO2 film, in two or more electrodes containing bus bars other than IDT, or the pad for connection with the exterior, the laminating is carry out on the substrate metal layer which consists these two or more electrodes of the same ingredient as IDT, respectively, and the substrate metal layer, and what consists of an upper metal layer which consists of aluminum or an aluminum alloy may be use. That is, the laminating of the aluminum film may be carried out on the substrate metal layer which consists of the same ingredient as IDT(s) 23a and 23b as an electrode layer which constitutes the reflectors 24a and 24b shown, for example in drawing 15 , and this substrate metal layer. Thus, adhesion reinforcement with SiO2 film is raised by preparing the upper metal layer which consists of aluminum or an aluminum alloy. Moreover, electrode cost can also be reduced and aluminum wedge bond nature can also be raised further.
[0110]
In addition, the leading-about electrode formed as electrodes other than Above IDT a reflector, a bus bar, and not only the pad for electrode-

connection with the exterior but if needed is mentioned. Moreover, especially as the above-mentioned aluminum alloy, although not limited, an aluminum-Ti alloy, an aluminum-nickel-Cr alloy, etc. are mentioned.
[0111]
In addition, when IDT which consists of Au when rotation Y cut X propagation $LiTaO_3$ substrate of Eulerian angles other than a case of the example of an experiment mentioned above is used is formed, it is confirmed by the invention-in-this-application person etc. that the thickness of SiO_2 film which makes an attenuation coefficient alpha min exists. That is, an attenuation coefficient alpha can be made small for thickness Hs/lambda of SiO_2 film like the case of the specific range, then the above-mentioned example of an experiment. On the other hand, the Eulerian angle when setting thickness Hs/lambda of SiO_2 film to 0.1-0.45 and the relation of alpha are shown in drawing 28 -36. It also became clear from these drawings that theta of the Eulerian angle from which alpha becomes the minimum becomes small as the thickness of SiO_2 film became thick. Therefore, even if it is the case where rotation Y cut X propagation $LiTaO_3$ substrate of other Eulerian angles is used, by forming IDT which consists of Au and choosing the thickness of SiO_2 film in the structure which carried out the laminating of the SiO_2 film, compared with conventional surface acoustic wave equipment, the frequency temperature characteristic TCF is as good as below one half, and can constitute surface acoustic wave equipment with a big reflection coefficient greatly [an electromechanical coupling coefficient]. It is confirmed that it is as a desirable combination of the Eulerian angle of $LiTaO_3$ substrate which may discover such effectiveness, the electrode layer thickness of IDT which consists of Au, and the thickness of SiO_2 film being shown by the following Table 16 and 17.
[0112]
[Table 16]

オイラー角 (0±3°, θ, 0±3°) のθ	Au膜厚	SiO_2膜厚
120.0° ≦θ<123.0°	0.013～0.018	0.15～0.45
123.0° ≦θ<124.5°	0.013～0.022	0.10～0.40
124.5° ≦θ<125.5°	0.013～0.025	0.07～0.40
125.5° ≦θ<127.5°	0.013～0.025	0.06～0.40
127.5° ≦θ<129.0°	0.013～0.028	0.04～0.40
129.0° ≦θ<130.0°	0.017～0.030	0.03～0.42
130.0° ≦θ<131.5°	0.017～0.030	0.03～0.42
131.5° ≦θ<133.0°	0.018～0.028	0.05～0.33
133.0° ≦θ<135.0°	0.018～0.030	0.05～0.30
135.0° ≦θ≦137.0°	0.019～0.032	0.05～0.25
137.0° ≦θ≦140.0°	0.019～0.032	0.05～0.25

[0113]
[Table 17]

オイラー角 (0±3°, θ, 0±3°) のθ	Au膜厚	SiO_2膜厚
129.0° ≦θ<130.0°	0.022～0.028	0.04～0.40
130.0° ≦θ<131.5°	0.022～0.028	0.04～0.40
131.5° ≦θ<133.0°	0.022～0.028	0.05～0.33
133.0° ≦θ<135.0°	0.022～0.030	0.05～0.30
135.0° ≦θ<137.0°	0.022～0.032	0.05～0.25
137.0° ≦θ≦140.0°	0.022～0.032	0.05～0.25

[0114]
In addition, -2 degrees - +4 degrees theta of an Eulerian angle may shift from a desired include angle. Since the count result in this application specification is calculated from the thing in which the metal membrane was formed all over the substrate, with actual surface

acoustic wave equipment, an error may generate this gap in the above-mentioned range.
[0115]
After forming IDT which consists of a metal which uses Au as a principal component on rotation Y cut X propagation LiTaO3 substrate on the occasion of manufacture of the surface acoustic wave equipment concerning this invention, it is desirable to form SiO2 film of the thickness of the range which performs frequency regulation in the condition and can make an attenuation coefficient alpha small after an appropriate time. This is explained with reference to drawing 23 and drawing 24 . Drawing 23 shows change of the acoustic velocity of the leakage surface acoustic wave at the time of forming IDT which consists of Au of various thickness, and SiO2 film of various thickness on 36-degree rotation Y cut X propagation (they being (0-degree, 126-degree, 0 degree) at Eulerian angle) LiTaO3 substrate. Moreover, drawing 24 shows change of the acoustic velocity of the leakage surface acoustic wave at the time of changing the standardization thickness of SiO2 film formed on it, when IDT which consists of Au of various thickness is formed on the LiTaO3 substrate of the same Eulerian angle. If drawing 23 is compared with drawing 24 , change of the acoustic velocity of a surface acoustic wave is far larger than the case where the direction at the time of changing the thickness of Au changes the thickness of SiO2 film so that clearly. Therefore, it is desirable to perform frequency regulation in advance of formation of SiO2 film, for example, after forming IDT which consists of Au by laser etching, ion etching, etc., it is desirable to perform frequency regulation. Especially, preferably, if the range of the standardization thickness of Au is 0.015-0.03, change of the acoustic velocity by SiO2 film becomes small, and the frequency drift by dispersion in SiO2 film can be made small.
[0116]
In addition, -2 degrees - +4 degrees theta of an Eulerian angle may shift from a desired include angle. Since the count result in this application specification is calculated from the thing in which the metal membrane was formed all over the substrate, with actual surface acoustic wave equipment, an error may generate this gap in the above-mentioned range.
[0117]
Moreover, although **3 degrees phi and psi of an Eulerian angle varied from 0 degree at the time of manufacture, the property as a 0-degree thing that a property is almost the same was acquired.
[electrode material is example [of Ag]].

The surface acoustic wave equipment of this example is the same as the surface acoustic wave equipment 21 shown in drawing 15 mentioned above. But IDT(s) 23a and 23b are constituted from this example by Ag.
[0118]
When IDT(s) 23a and 23b consist of Ag so that it may mention later, as for thickness H/lambda standardized on the wavelength of the surface acoustic wave of IDT(s) 23a and 23b, 0.01-0.08 are desirable.
[0119]
With the surface acoustic wave equipment which this invention requires, as mentioned above, IDT(s) 23a and 23b are constituted by Ag on LiTaO3 substrate 22, and this electrode layer thickness of IDT(s) 23a and 23b can be made thin. Since LiTaO3 substrate of an Eulerian angle is used, an attenuation coefficient can be sharply made small, and low loss-ization is attained. Moreover, the good frequency temperature characteristic is realized by formation of SiO2 film 25. This is explained based on the concrete example of an experiment.
[0120]
The leakage surface acoustic wave (LSAW) other than a Rayleigh wave is shown in the surface acoustic wave transmitted in LiTaO3 substrate. A leakage surface acoustic wave is spread emitting energy in a substrate, although the electromechanical coupling coefficient of acoustic velocity is large early compared with a Rayleigh wave. Therefore, a leakage surface acoustic wave has an attenuation coefficient leading to a propagation loss.
[0121]
Drawing 36 indicates relation with an electromechanical coupling coefficient Ksaw to be standardization thickness H/lambda of Ag film at the time of forming IDT which consists of Ag on 36-degree rotation Y cut X propagation LiTaO3 substrate (they being (0 degree, 126 degrees, 0 degree) at an Eulerian angle). In addition, lambda shall show the wavelength in the center frequency of surface acoustic wave equipment.
[0122]
It turns out that thickness H/lambda of Ag film becomes [an electromechanical coupling coefficient Ksaw] 1.5 or more times in the range of 0.01-0.08 compared with the case (H/lambda = 0) where Ag film is not formed so that clearly from drawing 36 . Moreover, compared with the case where Ag film is not formed for the thickness of Ag film in H/lambda =0.02-0.06, it turns out that an electromechanical coupling coefficient Ksaw serves as a value of 1.7 times or more, and thickness H/lambda of Ag film serves as a value of 1.8 times or more in case Ag film is not formed in 0.03-0.05.

[0123]
If standardization thickness H/lambda of Ag film exceeds 0.08, production of IDT which consists of Ag film will become difficult. Therefore, as for the thickness of IDT which can obtain a big electromechanical coupling coefficient, and consists of Ag film since production of IDT is easy, it is desirable that it is the range of 0.01-0.08, and it considers as the range of 0.03-0.05 preferably [it is more desirable and] to 0.02 to 0.06, and a pan.
[0124]
Next, change of the frequency temperature coefficient TCF at the time of forming SiO2 film on LiTaO3 substrate is shown in drawing 37 . drawing 37 -- an Eulerian angle (0 degree, 113 degrees, 0 degree) -- and (0 degree, 126 degrees, 0 degree) (0 degree, 129 degrees, 0 degree) shows the relation between standardization thickness Hs/lambda of SiO2 film in case SiO2 film is formed on three kinds of LiTaO3 substrates, and TCF. In addition, the electrode is not formed here.
[0125]
When theta is any which are 113 degrees, 126 degrees, and 129 degrees so that clearly from drawing 37 , it turns out that standardization thickness Hs/lambda of SiO2 film serves as range whose TCF is -20-+20ppm/degree C in the range of 0.15-0.45. But in order for membrane formation of SiO2 film to take time amount, as for thickness Hs/lambda of SiO2 film, 0.15-0.40 are desirable.
[0126]
Although it was known that TCF(s), such as a Rayleigh wave, will be improved by forming SiO2 film on LiTaO3 substrate, the electrode which consists of Ag is formed on LiTaO3 substrate, and there is no report in which it actually experimented in consideration of the attenuation coefficient of the thickness of the electrode which consists of Ag, the thickness of SiO2, an Eulerian angle, and a leakage elastic wave in the structure which carried out the laminating of the SiO2 film further.
[0127]
Drawing 38 shows change of the attenuation coefficient alpha when the electrode with which standardization thickness H/lambda consists of 0.10 or less Ag, and standardization thickness Hs/lambda form SiO2 film of 0-0.5 on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree). When thickness Hs/lambda of SiO2 film is [thickness H/lambda of 0.2 to 0.40 and Ag film] 0.01-0.10 so that clearly from drawing 38 , it turns out that the attenuation coefficient alpha is small.
[0128]
On the other hand, on the LiTaO3 substrate of the Eulerian angle of (0

degree, 140 degrees, 0 degree), standardization thickness H/lambda forms Ag film of 0-0.10, and drawing 39 shows change of the attenuation coefficient alpha when standardization thickness Hs/lambda forms SiO2 film of 0-0.5 further.

[0129]

Though the thickness of Ag film changes the thickness of SiO2 film as mentioned above or less in 0.06 when LiTaO3 theta= 140-degree substrate is used by the Eulerian angle so that clearly from drawing 39 , it turns out that an attenuation coefficient alpha is large.

[0130]

That is, in order to realize good TCF, a big electromechanical coupling coefficient, and a small attenuation coefficient, it turns out that it is necessary to combine the cut angle of LiTaO3 substrate, i.e., an Eulerian angle, the thickness of SiO2 film, and the thickness of the electrode which consists of Ag, respectively so that it may be the optimal.

[0131]

Standardization thickness Hs/lambda of SiO2 film is 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, and 0.4 or 0.45, and drawing 40 - drawing 47 show theta when standardization thickness H/lambda forms 0.1 or less Ag film on LiTaO3 substrate, and relation with an attenuation coefficient alpha, respectively.

[0132]

If the thickness of SiO2 film and theta of an Eulerian angle are chosen so that it may become one of the combination shown in the following table 18 when thickness H/lambda of Ag film is set to 0.01-0.08 so that clearly from drawing 40 - drawing 47 , the frequency temperature characteristic TCF is good, and an electromechanical coupling coefficient is large, and it turns out that an attenuation coefficient alpha can be controlled effectively. Desirably, a much more good property can be acquired by choosing the more desirable Eulerian angle on the right-hand side of the following table 18.

[0133]

[Table 18]

Ａｇ膜厚Ｈ／λ：０．０１～０．０８のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角	より好ましいオイラー角
０．１５～０．１８	０±３，１１７～１３７，０±３	０±３，１２０～１３５，０±３
０．１８～０．２３	０±３，１１７～１３６，０±３	０±３，１１８～１３３，０±３
０．２３～０．２８	０±３，１１５～１３５，０±３	０±３，１１７～１３３，０±３
０．２８～０．３３	０±３，１１３～１３３，０±３	０±３，１１５～１３２，０±３
０．３３～０．３８	０±３，１１３～１３５，０±３	０±３，１１５～１３３，０±３
０．３８～０．４０	０±３，１１３～１３２，０±３	０±３，１１５～１３０，０±３

[0134]
Moreover, if it is more preferably chosen so that the thickness of SiO2 film and theta of an Eulerian angle may become one of the combination shown in the following table 19 when the standardization thickness of Ag film is 0.02-0.06, a much more good property can be acquired much more desirable still more desirably by choosing the more desirable Eulerian angle on the right-hand side of the following table 19.
[0135]
[Table 19]

Ａｇ膜厚Ｈ／λ：０．０２～０．０６のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角	より好ましいオイラー角
０．１５～０．１８	０±３，１２０～１３３，０±３	０±３，１２２～１３０，０±３
０．１８～０．２３	０±３，１２０～１３７，０±３	０±３，１２２～１３６，０±３
０．２３～０．２８	０±３，１２０～１３５，０±３	０±３，１２２～１３３，０±３
０．２８～０．３３	０±３，１１８～１３５，０±３	０±３，１２０～１３３，０±３
０．３３～０．３８	０±３，１１５～１３３，０±３	０±３，１１７～１３０，０±３
０．３８～０．４０	０±３，１１３～１３０，０±３	０±３，１１５～１２８，０±３

[0136]
If it is chosen still more preferably so that the thickness of SiO2 film and theta of an Eulerian angle may become one of the combination shown in the following table 20 when the standardization thickness of Ag film is 0.03-0.05, a much more good property can be acquired. Also in this case, a property can be further improved by choosing a desirable Eulerian angle rather than it is shown in the right-hand side of the

following table 20.
[0137]
[Table 20]

Ａｇ膜厚Ｈ／λ：０．０３～０．０５のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角	より好ましいオイラー角
０．１５～０．１８	０±３，１２２～１４２，０±３	０±３，１２３～１４０，０±３
０．１８～０．２３	０±３，１２０～１４０，０±３	０±３，１２２～１３７，０±３
０．２３～０．２８	０±３，１１７～１３８，０±３	０±３，１２０～１３５，０±３
０．２８～０．３３	０±３，１１６～１３６，０±３	０±３，１１８～１３４，０±３
０．３３～０．３８	０±３，１１４～１３５，０±３	０±３，１１７～１３３，０±３
０．３８～０．４０	０±３，１１３～１３０，０±３	０±３，１１５～１２８，０±３

[0138]
In addition, by this invention, although IDT may consist of only Ag, as long as Ag is made into a subject, it may consist of layered products of Ag alloy, or Ag and other metals. In IDT which makes Ag a subject, 80% of the weight or more of the whole IDT should just be Ag. Therefore, aluminum thin film and Ti thin film may be formed in the substrate of Ag, and 80 % of the weight or more out of the sum total of the thin film of a substrate and Ag should just consist of Ag also in this case.
[0139]
In the above-mentioned experiment, although LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) was used, in the Eulerian angle of a substrate ingredient, 0**3-degree dispersion usually occurs in phi and psi. Within the limits (0**3 degrees, 113 degrees - 142 degrees, 0**3 degrees) it is such dispersion, the effectiveness of this invention is acquired also in LiTaO3 substrate.
[0140]
In addition, -2 degrees - +4 degrees theta of an Eulerian angle may shift from a desired include angle. Since the count result in this application specification is calculated from the thing in which the metal membrane was formed all over the substrate, with actual surface acoustic wave equipment, an error may generate this gap in the above-mentioned range.
[0141]
[The example at the time of using Cu as an electrode material]
If it removed having formed the electrode by Cu, the surface acoustic wave equipment shown in drawing 15 like the case where Au is used was

constituted. Since the electrode is constituted by Cu with a high consistency compared with aluminum, an electromechanical coupling coefficient and a reflection coefficient can be raised.
[0142]
Drawing 58 is drawing showing the reflection factor per electrode layer of Cu electrode in case the standardization thickness of SiO2 film is 0.20, and aluminum electrode, and relation with electrode layer thickness.
Since the reflection factor per electrode finger is raised when the electrode which consists of Cu is used compared with the electrode which consists of aluminum used conventionally, as shown in drawing 58 , the number of the electrode finger in a reflector can also be reduced. Therefore, the miniaturization of a reflector, as a result the miniaturization of surface acoustic wave equipment can be attained.
[0143]
As for thickness H/lambda standardized on the wavelength of the surface acoustic wave of IDT(s) 23a and 23b, 0.01-0.08 are desirable so that it may mention later.
Drawing 48 shows change of the attenuation coefficient alpha when the electrode with which standardization thickness H/lambda consists of 0.10 or less Cu, and standardization thickness Hs/lambda form SiO2 film of 0-0.5 on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree). When thickness Hs/lambda of SiO2 film is [thickness H/lambda of 0.2 to 0.40 and Cu film] 0.01-0.10 so that clearly from drawing 48 , it turns out that the attenuation coefficient alpha is small.
[0144]
On the other hand, on the LiTaO3 substrate of the Eulerian angle of (0 degree, 135 degrees, 0 degree), standardization thickness H/lambda forms Cu film of 0-0.10, and drawing 49 shows change of the attenuation coefficient alpha when standardization thickness Hs/lambda forms SiO2 film of 0-0.5 further.
[0145]
Though the thickness of Cu film and the thickness of SiO2 film are changed as mentioned above when LiTaO3 theta= 135-degree substrate is used so that clearly from drawing 49 , it turns out that an attenuation coefficient alpha is large.
[0146]
That is, in order to realize good TCF, a big electromechanical coupling coefficient, and a small attenuation coefficient, it turns out that it is necessary to combine the cut angle of LiTaO3 substrate, i.e., an Eulerian angle, the thickness of SiO2 film, and the thickness of the

electrode which consists of Cu, respectively so that it may be the optimal.

[0147]

Standardization thickness Hs/lambda of SiO2 film is 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, and 0.4 or 0.45, and drawing 50 - drawing 57 show theta when standardization thickness H/lambda forms 0.08 or less Cu film on LiTaO3 substrate, and relation with an attenuation coefficient alpha, respectively.

[0148]

If the thickness of SiO2 film and theta of an Eulerian angle are chosen as shown in the following table 21 when thickness H/lambda of Cu film is set to 0.01-0.08 so that clearly from drawing 50 - drawing 57 , it considers as within the limits whose frequency temperature characteristic TCF is **20ppm/degree C, and it is good, and an electromechanical coupling coefficient is large, and it turns out that an attenuation coefficient alpha can be controlled effectively. Desirably, a much more good property can be acquired by choosing the more desirable Eulerian angle on the right-hand side of the following table 21.

[0149]

[Table 21]

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角	より好ましくは
０．１５～０．１８	(0±３，１１７～１３７，０±３)	(0±３，１２０～１３５，０±３)
０．１８～０．２３	(0±３，１１７～１３６，０±３)	(0±３，１１８～１３３，０±３)
０．２３～０．２８	(0±３，１１５～１３５，０±３)	(0±３，１１７～１３３，０±３)
０．２８～０．３３	(0±３，１１３～１３３，０±３)	(0±３，１１５～１３２，０±３)
０．３３～０．３８	(0±３，１１３～１３５，０±３)	(0±３，１１５～１３３，０±３)
０．３８～０．４	(0±３，１１３～１３２，０±３)	(0±３，１１５～１３０，０±３)

[0150]

Moreover, when theta of an Eulerian angle becomes 125 degrees or less so that it may be guessed from drawing 25 about Au, it turns out that an electromechanical coupling coefficient Ksaw becomes remarkably large. Therefore, it turns out that the combination of the standardization thickness Hs/lambda of SiO2 film and the Eulerian angle which are shown in the following table 22 is desirable more preferably.

[0151]

[Table 22]

SiO_2膜厚	$LiTaO_3$のオイラー角
０．１５～０．１８	(0±3，１１７～１２５，0±3)
０．１８～０．２３	(0±3，１１７～１２５，0±3)
０．２３～０．２８	(0±3，１１５～１２５，0±3)
０．２８～０．３３	(0±3，１１３～１２５，0±3)
０．３３～０．３８	(0±3，１１３～１２５，0±3)
０．３８～０．４０	(0±3，１１３～１２５，0±3)

[0152]
Furthermore, the result of having searched for the Eulerian angle from which an attenuation coefficient serves as 0 or min, i.e., thetamin, from the result shown in drawing 48 - drawing 56 from standardization thickness Hs/lambda of SiO2 film and standardization thickness H/lambda of Cu film is shown in drawing 59 .
[0153]
When standardization thickness H/lambda of Cu film approximates each curve shown in drawing 59 in 0, 0.02, 0.04, and 0.06 and 0.08 by the cubic polynomial, following formula A-E is obtained.
(a) At the time of 0< H/lambda <=0.01
thetamin=-139.713xHs3+43.07132xHs2
- 20.568011xHs+125.8314 -- Formula A
(b) At the time of 0.01< H/lambda <=0.03
thetamin=-139.660xHs3+46.02985xHs2
- 21.141500xhs+127.4181 -- At the time of formula B(c)0.03< H/lambda <=0.05
thetamin=-139.607xHs3+48.98838xHs2
- 21.714900xHs+129.0048 -- At the time of formula C(d)0.05< H/lambda <=0.07
thetamin=-112.068xHs3+39.60355xHs2
- 21.186000xHs+129.9397 -- At the time of formula D(e)0.07< H/lambda <=0.09
thetamin=-126.954xHs3+67.40488xHs2
- 29.432000xHs+131.5686 -- Formula E
Therefore, preferably, although it is desirable to be referred to as thetamin shown by the formula A mentioned above - Formula E as for theta of an Eulerian angle (0**3 degrees, theta, 0**3 degrees), if it is thetamin-2 degree< theta<=theta min+2 degree, it can make an attenuation coefficient small effectively.
[0154]

In addition, although IDT may consist of only Cu(s), as long as Cu is made into a subject, it may be constituted from this invention by the layered product of Cu alloy, or Cu and other metals. If mean density of an electrode is set to rho (average) in IDT which makes Cu a subject
rho(Cu) x0.7 <=rho(average) <=rho(Cu) x1.3
namely
6.25 g/cm3 <=rho(average) <=11.6 g/cm3
What is necessary is just satisfied. In addition, the laminating of the electrode which consists of metals, such as W, Ta, Au, Pt, Ag, or Cr with a larger consistency than aluminum, may be carried out so that rho (average) of the whole electrode may become the above-mentioned range on Cu or in the bottom. Also in such a case, the same effectiveness as the case of Cu electrode monolayer is acquired.
[0155]
In addition, -2 degrees - +4 degrees theta of an Eulerian angle may shift from a desired include angle. Since the count result in this application specification is calculated from the thing in which the metal membrane was formed all over the substrate, with actual surface acoustic wave equipment, an error may generate this gap in the above-mentioned range.
[0156]
Moreover, although **3 degrees phi and psi of an Eulerian angle varied from 0 degree at the time of manufacture, the property as a 0-degree thing that a property is almost the same was acquired.
[The example using the tungsten as an electrode material]
The surface acoustic wave equipment shown in drawing 15 was constituted like the example mentioned above. However, the tungsten constituted IDT and a reflector. Standardization thickness H/lambda of IDT was taken as the range of 0.0025-0.06.
[0157]
Moreover, as $LiTaO_3$ substrate, $LiTaO_3$ substrate of (0 degree, 112 degrees - 138 degrees, 0 degree) was used by 22 degrees - 48 degree rotation Y cut X propagation and the Eulerian angle.
IDT(s) 3a and 3b which serve as the piezo-electric substrate 22 which consists of 22 degrees - 48 degree rotation Y cut X propagation $LiTaO_3$ from the tungsten which is H/lambda =0.0025-0.06 as mentioned above in this example, and Hs/lambda = since SiO_2 film 4 in the range of 0.10-0.40 is used, the frequency temperature coefficient TCF is small and a propagation loss can offer small surface acoustic wave equipment greatly [an electromechanical coupling coefficient Ksaw]. This is explained based on the following concrete examples of an experiment.

[0158]
drawing 60 and drawing 61 -- an Eulerian angle (0 degree, 120 degrees, 0 degree) and every of (0 degree, 140 degrees, 0 degree) -- it is drawing showing the attenuation coefficient at the time of forming IDT which consists of a tungsten of various thickness, and SiO2 film of various thickness on LiTaO3 substrate.
[0159]
At theta= 120 degrees, it turns out that standardization thickness H/lambda of the electrode with which thickness Hs/lambda of SiO2 consists of 0.1-0.40, and a tungsten has a small attenuation coefficient in the range of 0.0-0.10 so that clearly from drawing 60 . On the other hand, at theta= 140 degrees, it turns out that the attenuation coefficient is [standardization thickness H/lambda of the electrode which consists of a tungsten] large regardless of the thickness of SiO2 film in 0.0-0.10 so that clearly from drawing 61 .
[0160]
That is, in order to make TCF small with **20ppm/degree C, and to obtain a big electromechanical coupling coefficient and to make an attenuation coefficient small, it turns out that three conditions of the thickness of the electrode which consists of the thickness and the tungsten of the Eulerian angle of LiTaO3 substrate and SiO2 film must be taken into consideration.
[0161]
Drawing 62 - drawing 65 show the relation of the theta (degree) and the attenuation coefficient at the time of changing standardization thickness H/lambda of the electrode layer which consists of standardization thickness Hs/lambda and the tungsten of SiO2 film.
[0162]
In 0.012-0.053, and 0.015-0.042, it becomes as standardization thickness H/lambda of the electrode which consists of a tungsten shows the thickness of SiO2 film, and the relation with optimal theta in the following Table 23 and 24, so that clearly from drawing 62 - drawing 65 . In addition, this -2 degrees - about +4 degrees optimal theta may vary by dispersion in the electrode digit of a wolfram electrode, or dispersion of a single crystal substrate. In addition, the thickness which is not illustrated is based on proportional distribution among drawing.
[0163]
[Table 23]

電極の H/λ＝0.012～0.053 のとき

SiO_2の規格化膜厚	$LiTaO_3$のオイラー角	より好ましくは
0.1～0.15	(0±3, 114.2～138, 0±3)	(0±3, 117.7～134, 0±3)
0.15～0.2	(0±3, 113～137.8, 0±3)	(0±3, 117～133.5, 0±3)
0.2～0.3	(0±3, 113～137.5, 0±3)	(0±3, 116.5～133, 0±3)
0.3～0.35	(0±3, 112.7～137, 0±3)	(0±3, 116.5～133, 0±3)
0.35～0.4	(0±3, 112.5～136, 0±3)	(0±3, 116.5～132.3, 0±3)

[0164]
[Table 24]

電極の H/λ＝0.015～0.042 のとき

SiO_2の規格化膜厚	$LiTaO_3$のオイラー角	より好ましくは
0.1～0.15	(0±3, 114.3～138, 0±3)	(0±3, 117.7～133.5, 0±3)
0.15～0.2	(0±3, 113～137.5, 0±3)	(0±3, 117.7～133.5, 0±3)
0.2～0.3	(0±3, 112.5～137, 0±3)	(0±3, 117～132.5, 0±3)
0.3～0.35	(0±3, 112.2～136.5, 0±3)	(0±3, 116.8～132.5, 0±3)
0.35～0.4	(0±3, 112～135.3, 0±3)	(0±3, 116～131.5, 0±3)

[0165]
Namely, in order that thickness H/lambda of the electrode which consists of a tungsten may improve the frequency temperature characteristic TCF in the case of 0.012-0.053 so that it may become within the limits of **20ppm/degree C so that clearly from Table 23 and 24 When thickness Hs/lambda of SiO2 film is made into the range of 0.1-0.4, it turns out that theta in the Eulerian angle of LiTaO3 should just choose the range of 20 degrees - 50 degrees, and the Eulerian angle more preferably shown in Table 23 in the range of 112 degrees - 138 degrees, i.e., an angle of rotation.
[0166]
In order similarly for the standardization thickness of the electrode which consists of tungsten film to be 0.015-0.042, and to improve the frequency temperature characteristic TCF so that it may become within the limits of **20ppm/degree C so that clearly from Table 24 When thickness Hs/lambda of SiO2 film is made into the range of 0.1-0.4, it is good and, as for the Eulerian angle of LiTaO3 substrate, it turns out

that what is necessary is the range of 112 degrees - 138 degrees, then just to choose the Eulerian angle of Table 24 according to the thickness of SiO2 film more preferably.

[0167]

Here, as for the range of "the Eulerian angle of LiTaO3" in Table 23 and 24, an attenuation coefficient specifies 0.05 or less range. Moreover, an attenuation coefficient specifies the range the Eulerian angle of LiTaO3 in Table 23 and 24 "is more desirable in the range" or less to 0.025. Moreover, it converts and asks for thickness Hs/lambda of SiO2 film in case the standardization thickness of the electrode layer which consists of a tungsten is 0.012, 0.015, 0.042, and 0.053, and the relation of an Eulerian angle from the standardization thickness of the electrode layer which consists of a tungsten shown in drawing 62 R> 2 - drawing 65 , and they are calculating the thickness of SiO2 film of Table 23 and 24, and the value of an Eulerian angle by it.

[0168]

After forming IDT which consists of a metal which uses a tungsten as a principal component on rotation Y cut X propagation LiTaO3 substrate on the occasion of manufacture of the surface acoustic wave equipment concerning this invention, it is desirable to form SiO2 film of the thickness of the range which performs frequency regulation in the condition and can make an attenuation coefficient alpha small after an appropriate time. This is explained with reference to drawing 66 and drawing 67 . Drawing 66 shows change of the acoustic velocity of the leakage surface acoustic wave at the time of forming SiO2 film of IDT which consists of a tungsten of various thickness H/lambda, and various thickness Hs/lambda on the rotation Y cut X propagation LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree). Moreover, drawing 67 shows change of the acoustic velocity of the leakage surface acoustic wave at the time of changing standardization thickness Hs/lambda of SiO2 film formed on it, when IDT which consists of a tungsten of various thickness H/lambda is formed on the LiTaO3 substrate of the same Eulerian angle. If drawing 6666 is compared with drawing 67 , change of the acoustic velocity of a surface acoustic wave is far larger than the case where the direction at the time of changing the thickness of a tungsten changes the thickness of SiO2 film so that clearly. Therefore, it is desirable to perform frequency regulation in advance of formation of SiO2 film, for example, after forming IDT which consists of a tungsten (W) by laser etching, ion etching, etc., it is desirable to perform frequency regulation.

[0169]

In addition, IDT which this invention becomes from 22 degrees - 48 degree rotation Y cut X propagation, the piezo-electric substrate which consists of LiTaO3 of (0 degree, 112 degrees - 138 degrees, 0 degree) by the Eulerian angle, and the tungsten which is H/lambda =0.0025-0.06 as mentioned above and Hs/lambda = it is not characterized by having SiO2 film which is 0.10-0.40, and is not limited [therefore] especially about a number, structure, etc. of IDT. That is, this invention is applicable to various surface acoustic wave resonators, a surface acoustic wave filter, etc., as long as not only the surface acoustic wave equipment shown in drawing 15 but the above-mentioned conditions are fulfilled.
[0170]
In addition, -2 degrees - +4 degrees theta of an Eulerian angle may shift from a desired include angle. Since the count result in this application specification is calculated from the thing in which the metal membrane was formed all over the substrate, with actual surface acoustic wave equipment, an error may generate this gap in the above-mentioned range.
Moreover, although **3 degrees phi and psi of an Eulerian angle varied from 0 degree at the time of manufacture, the property as a 0-degree thing that a property is almost the same was acquired.
[0171]
[The example at the time of using Ta as an electrode material]
The surface acoustic wave equipment shown in drawing 15 was constituted. However, using the substrate which consists of LiTaO3 of (0 degree, 104 degrees - 148 degrees, 0 degree) by 14 degrees - 58 degree rotation Y cut X propagation and the Eulerian angle as a piezoelectric substrate 22, the tantalum (Ta) constituted IDT and the standardization thickness H/lambda was taken as the range of 0.004-0.055.
[0172]
The piezo-electric substrate 2 which consists of LiTaO3 of (0 degree, 104 degrees - 148 degrees, 0 degree) as mentioned above in this example according to 14 degrees - 58 degree rotation Y cut X propagation and an Eulerian angle, IDT(s) 3a and 3b which consist of a tantalum which is H/lambda =0.004-0.055, and Hs/lambda = Since SiO2 film 4 in the range of 0.10-0.40 is used, The frequency temperature coefficient TCF is small and a propagation loss can offer small surface acoustic wave equipment greatly [an electromechanical coupling coefficient Ksaw]. This is explained based on the following concrete examples of an experiment.
[0173]
drawing 68 and drawing 69 -- an Eulerian angle (0 degree, 120 degrees, 0

degree) and every of (0 degree, 140 degrees, 0 degree) -- it is drawing showing the attenuation coefficient at the time of forming IDT which consists of a tantalum of various thickness, and SiO2 film of various thickness on LiTaO3 substrate.

[0174]

At theta= 120 degrees, it turns out that standardization thickness H/lambda of the electrode with which thickness Hs/lambda of SiO2 consists of 0.1-0.40, and a tantalum has a small attenuation coefficient in the range of 0.0-0.10 so that clearly from drawing 68 . On the other hand, at theta= 140 degrees, it turns out that the attenuation coefficient is [standardization thickness H/lambda of the electrode which consists of a tantalum] large regardless of the thickness of SiO2 film in 0.0-0.06 so that clearly from drawing 69 .

[0175]

That is, in order to make the absolute value of TCF small, and to obtain a big electromechanical coupling coefficient and to make an attenuation coefficient small, it turns out that three conditions of the thickness of the electrode which consists of the thickness and the tantalum of the Eulerian angle of LiTaO3 substrate and SiO2 film must be taken into consideration.

[0176]

Drawing 70 - drawing 73 show the relation of the theta and the attenuation coefficient at the time of changing standardization thickness H/lambda of the electrode layer which consists of standardization thickness Hs/lambda and the tantalum of SiO2 film. In 0.01-0.055, and 0.016-0.045, it becomes as standardization thickness H/lambda of the electrode which consists of a tantalum shows the thickness of SiO2 film, and the relation with optimal theta in the following Table 25 and 26, so that clearly from drawing 70 - drawing 73 . In addition, this -2 degrees - about +4 degrees optimal theta may vary by dispersion in the electrode digit of a tantalum electrode, or dispersion of a single crystal substrate.

[0177]

[Table 25]

電極の H/λ＝0.01～0.055 のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角	より好ましくは
0.1～0.15	(0±3, 110.5～148, 0±3)	(0±3, 116～143, 0±3)
0.15～0.2	(0±3, 108～147.5, 0±3)	(0±3, 115～141.5, 0±3)
0.2～0.3	(0±3, 105～148, 0±3)	(0±3, 111～139, 0±3)
0.3～0.35	(0±3, 104.5～148, 0±3)	(0±3, 111～139, 0±3)
0.35～0.4	(0±3, 104～145, 0±3)	(0±3, 110～138.5, 0±3)

[0178]
[Table 26]

電極の H/λ＝0.016～0.045 のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角	より好ましくは
0.1～0.15	(0±3, 113～144, 0±3)	(0±3, 118～140, 0±3)
0.15～0.2	(0±3, 111～144, 0±3)	(0±3, 117～139.5, 0±3)
0.2～0.3	(0±3, 108～144, 0±3)	(0±3, 113～139, 0±3)
0.3～0.35	(0±3, 107.5～143, 0±3)	(0±3, 112.5～137, 0±3)
0.35～0.4	(0±3, 107～140.5, 0±3)	(0±3, 112～135.5, 0±3)

[0179]
Namely, in order that thickness H/lambda of the electrode which consists of a tantalum may improve in the case of 0.01-0.055 so that the frequency temperature characteristic TCF may be made into within the limits of **20ppm/degree C so that clearly from Table 25 and 26 When standardization thickness of SiO2 film is made into the range of 0.1-0.4, theta in the Eulerian angle of LiTaO3 It turns out in the range of 104 degrees - 148 degrees, i.e., an angle of rotation, that what is necessary is just to choose the range of 14 degrees - 58 degrees, and the Eulerian angle more preferably shown in Table 25 according to thickness Hs/lambda of SiO2.
[0180]
Similarly, the standardization thickness of the electrode which consists of tantalum film is 0.016-0.045, and in order to improve the frequency temperature characteristic TCF, when thickness Hs/lambda of SiO2 film is

made into the range of 0.1-0.4, it is good and, as for the Eulerian angle of LiTaO3 substrate, it turns out that what is necessary is the range of 107 degrees - 144 degrees, then just to choose the Eulerian angle of Table 26 according to thickness Hs/lambda of SiO2 film more preferably, so that clearly from Table 26.

[0181]

As for the range of the Eulerian angle of LiTaO3, an attenuation coefficient specifies 0.05 or less range. Moreover, an attenuation coefficient specifies the more desirable range of the Eulerian angle of LiTaO3 in Table 25 and 26 or less to 0.025. Moreover, it converts and asks for thickness Hs/lambda of SiO2 film in case the standardization thickness of the electrode layer which consists of a tantalum is 0.012, 0.015, 0.042, and 0.053, and the relation of an Eulerian angle from the standardization thickness of the electrode layer which consists of a tantalum shown in drawing 70 - drawing 73 , and they are calculating thickness Hs/lambda of SiO2 film of Table 25 and 26, and the value of an Eulerian angle.

[0182]

After forming IDT which consists of a metal which uses a tantalum as a principal component on rotation Y cut X propagation LiTaO3 substrate on the occasion of manufacture of the surface acoustic wave equipment concerning this invention, it is desirable to form SiO2 film of the thickness of the range which performs frequency regulation in the condition and can make an attenuation coefficient alpha small after an appropriate time. This is explained with reference to drawing 74 and drawing 75 . Drawing 74 shows the relation between standardization thickness H/lambda of a tantalum at the time of forming IDT and SiO2 film which consists of a tantalum on the rotation Y cut X propagation LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), standardization thickness Hs/lambda of SiO2 film, and the acoustic velocity of a leakage surface acoustic wave. Moreover, drawing 75 shows change of the acoustic velocity of the leakage surface acoustic wave at the time of changing the standardization thickness of SiO2 film which forms IDT which consists of a tantalum of various thickness on the LiTaO3 substrate of the same Eulerian angle, and is formed on it. If drawing 74 R> 4 is compared with drawing 75 , change of the acoustic velocity of a surface acoustic wave is far larger than the case where the direction at the time of changing the thickness of a tantalum changes the thickness of SiO2 film so that clearly. Therefore, it is desirable to perform frequency regulation in advance of formation of SiO2 film, for example, after forming IDT which consists of a tantalum

by laser etching, ion etching, etc., it is desirable to perform frequency regulation.
[0183]
In addition, IDT which this invention becomes from 14 degrees - 58 degree rotation Y cut X propagation, the piezo-electric substrate which consists of LiTaO3 of (0 degree, 104 degrees - 148 degrees, 0 degree) by the Eulerian angle, and the tantalum which is H/lambda =0.004-0.055 as mentioned above and Hs/lambda = it is not characterized by having SiO2 film which is 0.10-0.40, and is not limited [therefore] especially about a number, structure, etc. of IDT. That is, this invention is applicable to various surface acoustic wave resonators, a surface acoustic wave filter, etc., as long as not only the surface acoustic wave equipment shown in drawing 15 but the above-mentioned conditions are fulfilled.
[0184]
In addition, -2 degrees - +4 degrees theta of an Eulerian angle may shift from a desired include angle. Since the count result in this application specification is calculated from the thing in which the metal membrane was formed all over the substrate, with actual surface acoustic wave equipment, an error may generate this gap in the above-mentioned range.
Moreover, although **3 degrees phi and psi of an Eulerian angle varied from 0 degree at the time of manufacture, the property as a 0-degree thing that a property is almost the same was acquired.
[0185]
[The example using platinum as an electrode material]
The piezo-electric substrate which consists of LiTaO3 substrate of (0 degree, 90 degrees - 169 degrees, 0 degree) the surface acoustic wave equipment shown in drawing 15 by 0 degree - 79 degree rotation Y cut X propagation and the Eulerian angle, and H/lambda = it constituted using IDT which consists of platinum which is 0.005-0.054. Other points are the same as the example mentioned above.
[0186]
Also in this example, since it has the above-mentioned configuration, the frequency temperature coefficient TCF is small and a propagation loss can offer small surface acoustic wave equipment greatly [an electromechanical coupling coefficient Ksaw]. This is explained based on the following concrete examples of an experiment.
[0187]
drawing 76 and drawing 77 -- an Eulerian angle (0 degree, 125 degrees, 0 degree) and every of (0 degree, 140 degrees, 0 degree) -- it is drawing

showing the attenuation coefficient at the time of forming IDT which consists of platinum of various thickness, and SiO2 film of various thickness on LiTaO3 substrate.

[0188]

At theta= 125 degrees, it turns out that standardization thickness H/lambda of the electrode with which thickness Hs/lambda of SiO2 consists of 0.1-0.40, and platinum has a small attenuation coefficient in the range of 0.005-0.06 so that clearly from drawing 76 . On the other hand, at theta= 140 degrees, it turns out that the attenuation coefficient is [standardization thickness H/lambda of the electrode which consists of platinum] large regardless of thickness Hs/lambda of SiO2 film in 0.005-0.06 so that clearly from drawing 77 .

[0189]

That is, in order to make the absolute value of TCF small, and to obtain a big electromechanical coupling coefficient and to make an attenuation coefficient small, it turns out that three conditions of the thickness of the electrode which consists of the thickness and platinum of the Eulerian angle of LiTaO3 substrate and SiO2 film must be taken into consideration.

[0190]

Drawing 78 - drawing 83 show the relation between theta (degree) of an Eulerian angle at the time of changing standardization thickness H/lambda of the electrode layer which consists of standardization thickness Hs/lambda and platinum of SiO2 film, and an attenuation coefficient.

[0191]

It turns out that it is desirable for standardization thickness H/lambda of the electrode which consists of platinum to make theta the range of 90 degrees - 169 degrees in 0.005-0.054 so that clearly from drawing 78 - drawing 83 . Moreover, if standardization thickness H/lambda of the electrode which consists of platinum also takes into consideration that the relation between thickness Hs/lambda of SiO2 film and optimal theta reduces an attenuation coefficient alpha in 0.01-0.04, and 0.013-0.033, it will become as shown in the following Table 27 and 28. Here, as for the range of "the Eulerian angle of LiTaO3" in Table 27 and 28, an attenuation coefficient specifies the range of 0.05 or less dB/lambda. Moreover, as for the range the Eulerian angle of LiTaO3 in Table 27 and 28 "is more desirable in the range", an attenuation coefficient specifies the range of 0.025 or less dB/lambda. In addition, this -2 degrees - about +4 degrees optimal theta may vary by dispersion in the electrode digit of a platinum electrode, or dispersion of a single

crystal substrate.
[0192]
Moreover, although **3 degrees phi and psi of an Eulerian angle varied from 0 degree at the time of manufacture, the property as a 0-degree thing that a property is almost the same was acquired.
[0193]
[Table 27]

白金 H/λ＝0.01～0.04 のとき

SiO$_2$厚(Hs/λ)	オイラー角	より好ましいオイラー角
0.1 ≦ Hs/λ＜0.15	(0±3°, 90°～169°, 0±3°)	(0±3°, 105°～153°, 0±3°)
0.15≦ Hs/λ＜0.2	(0±3°, 90°～167°, 0±3°)	(0±3°, 105°～152°, 0±3°)
0.20≦ Hs/λ＜0.25	(0±3°, 90°～167°, 0±3°)	(0±3°, 107°～152°, 0±3°)
0.25≦ Hs/λ＜0.3	(0±3°, 90°～164°, 0±3°)	(0±3°, 104°～151°, 0±3°)
0.3 ≦ Hs/λ＜0.4	(0±3°, 90°～163°, 0±3°)	(0±3°, 105°～150°, 0±3°)

[0194]
[Table 28]

白金 H/λ＝0.013～0.033 のとき

SiO$_2$厚(Hs/λ)	オイラー角	より好ましいオイラー角
0.1 ≦ Hs/λ＜0.15	(0±3°, 106°～155°, 0±3°)	(0±3°, 116°～147.5°, 0±3°)
0.15≦ Hs/λ＜0.2	(0±3°, 104°～155°, 0±3°)	(0±3°, 113.5°～150°, 0±3°)
0.20≦ Hs/λ＜0.25	(0±3°, 102°～155°, 0±3°)	(0±3°, 111.5°～150°, 0±3°)
0.25≦ Hs/λ＜0.3	(0±3°, 102°～154°, 0±3°)	(0±3°, 112°～146°, 0±3°)
0.3 ≦ Hs/λ＜0.4	(0±3°, 102°～153°, 0±3°)	(0±3°, 110°～144.5°, 0±3°)

[0195]
Namely, in order that thickness H/lambda of the electrode which consists of platinum may improve the frequency temperature characteristic TCF in the case of 0.01-0.04 so that it may become within the limits of **20ppm/degree C so that clearly from Table 27 and 28 When thickness Hs/lambda of SiO2 film is made into the range of 0.1-0.4, it turns out that theta in the Eulerian angle of LiTaO3 should just choose the range of 0 degree - 79 degrees in the range of 90 degrees - 169 degrees, i.e., an angle of rotation.
[0196]
In order similarly for the standardization thickness of the electrode which consists of platinum film to be 0.01-0.04, and to improve the

frequency temperature characteristic TCF so that it may become within the limits of **20ppm/degree C so that clearly from Table 27 When thickness Hs/lambda of SiO2 film is made into the range of 0.1-0.4, it is good and, as for theta of the Eulerian angle of LiTaO3 substrate, it turns out that what is necessary is the range of 90 degrees - 169 degrees, then just to choose the Eulerian angle of Table 27 according to the thickness of SiO2 film more preferably.
[0197]
In order similarly for the standardization thickness of the electrode which consists of platinum film to be 0.013-0.033, and to improve the frequency temperature characteristic TCF so that it may become the range of **20ppm/degree C When thickness Hs/lambda of SiO2 film is made into the range of 0.1-0.4, it is good and, as for theta of the Eulerian angle of LiTaO3 substrate, it turns out more preferably that what is necessary is the range of 102 degrees - 150 degrees, then just to choose the Eulerian angle of Table 28 according to thickness Hs/lambda of SiO2 film.
[0198]
Moreover, it converts and asks for the thickness of SiO2 film in case the standardization thickness of the electrode layer which consists of platinum is 0.013-0.033, and the relation of an Eulerian angle from the standardization thickness of the electrode layer which consists of platinum shown in drawing 78 - drawing 83 , and they are calculating thickness Hs/lambda of SiO2 film of Table 27 and 28, and the value of an Eulerian angle by it.
[0199]
After forming IDT which consists of a metal which uses platinum as a principal component on rotation Y cut X propagation LiTaO3 substrate on the occasion of manufacture of the surface acoustic wave equipment concerning this invention, it is desirable to form SiO2 film of thickness Hs/lambda of the range which performs frequency regulation in the condition and can make an attenuation coefficient alpha small after an appropriate time. This is explained with reference to drawing 84 and drawing 85 . Drawing 84 shows change of the acoustic velocity of the leakage surface acoustic wave at the time of forming SiO2 film of IDT which consists of platinum of various thickness H/lambda, and various thickness Hs/lambda on the rotation Y cut X propagation LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree). Moreover, drawing 85 shows change of the acoustic velocity of the leakage surface acoustic wave at the time of changing standardization thickness Hs/lambda of SiO2 film formed on it, when IDT which consists of platinum of various thickness H/lambda is formed on the LiTaO3 substrate of the

same Eulerian angle. If drawing 84 is compared with drawing 85 , change of the acoustic velocity of a surface acoustic wave is far larger than the case where the direction at the time of changing the thickness of platinum changes the thickness of SiO2 film so that clearly. Therefore, it is desirable to perform frequency regulation in advance of formation of SiO2 film, for example, after forming IDT which consists of platinum by laser etching, ion etching, etc., it is desirable to perform frequency regulation.
[0200]
In addition, IDT which this invention becomes from 0 degree - 79 degree rotation Y cut X propagation, the piezo-electric substrate which consists of LiTaO3 of (0 degree, 90 degrees - 169 degrees, 0 degree) by the Eulerian angle, and the platinum which is H/lambda =0.005-0.054 as mentioned above and Hs/lambda = it is not characterized by having SiO2 film which is 0.10-0.40, and is not limited [therefore] especially about a number, structure, etc. of IDT. That is, this invention is applicable to various surface acoustic wave resonators, a surface acoustic wave filter, etc., as long as not only the surface acoustic wave equipment shown in drawing 1 but the above-mentioned conditions are fulfilled.
[0201]
[The example using nickel and molybdenum as an electrode material]
The surface acoustic wave equipment shown in drawing 15 was constituted. Nickel or molybdenum was used as an electrode material. Moreover, LiTaO3 substrate of (0 degree, 104 degrees - 140 degrees, 0 degree) was used as a piezoelectric substrate by 14 degrees - 50 degree rotation Y cut X propagation and the Eulerian angle. Other points are the same.
[0202]
IDT(s) 23a and 23b and Reflectors 25a and 25b are constituted by the metal 1.8x1011 to 4x1011Ns/m2, and whose transverse-wave acoustic velocity 8700 - 10300 kg-m3 and Young's modulus are 3170-3290m/second for a consistency. As such a metal, the alloy which makes nickel, molybdenum, or these a subject is mentioned.
[0203]
Let standardization thickness H/lambda (wavelength [in / H and / in lambda / center frequency] is shown) of IDT(s) 23a and 23b be the range of 0.008-0.06. [the thickness of IDT]
The piezo-electric substrate 22 which consists of LiTaO3 of (0 degree, 104 degrees - 140 degrees, 0 degree) as mentioned above in this example according to 14 degrees - 50 degree rotation Y cut X propagation and an Eulerian angle, IDT(s) 23a and 23b which are H/lambda =0.008-0.06 and

consist of the above-mentioned specific metal, and Hs/lambda = Since SiO2 film 24 in the range of 0.10-0.40 is used, It is made small so that the frequency temperature coefficient TCF may become within the limits which is **20ppm/degree C, and a propagation loss can offer small surface acoustic wave equipment greatly [an electromechanical coupling coefficient Ksaw]. This is explained based on the following concrete examples of an experiment.
[0204]
drawing 86 and drawing 87 -- an Eulerian angle (0 degree, 120 degrees, 0 degree) and every of (0 degree, 140 degrees, 0 degree) -- it is drawing showing the attenuation coefficient at the time of forming IDT which consists of nickel of various thickness, and SiO2 film of various thickness Hs/lambda on LiTaO3 substrate.
[0205]
At theta= 120 degrees, it turns out that standardization thickness H/lambda of the electrode with which thickness Hs/lambda of SiO2 consists of 0.1-0.40, and nickel has a small attenuation coefficient in the range of 0.008-0.08 so that clearly from drawing 86 . On the other hand, at theta= 140 degrees, it turns out that the attenuation coefficient is [standardization thickness H/lambda of the electrode which consists of nickel] large regardless of the thickness of SiO2 film in 0.008-0.08 so that clearly from drawing 87 .
[0206]
drawing 88 and drawing 89 -- an Eulerian angle (0 degree, 120 degrees, 0 degree) and every of (0 degree, 140 degrees, 0 degree) -- it is drawing showing change of the attenuation coefficient at the time of forming IDT which consists of Mo of various thickness, and SiO2 film of various thickness Hs/lambda on LiTaO3 substrate.
[0207]
At theta= 120 degrees, it turns out that standardization thickness H/lambda of the electrode with which thickness Hs/lambda of SiO2 consists of 0.1-0.40, and Mo has a small attenuation coefficient in the range of 0.008-0.08 so that clearly from drawing 88 . On the other hand, at theta= 140 degrees, it turns out that the attenuation coefficient is [standardization thickness H/lambda of the electrode which consists of Mo] large regardless of thickness Hs/lambda of SiO2 film in 0.008-0.08 so that clearly from drawing 89 .
[0208]
That is, in order to make the absolute value of TCF small, and to obtain a big electromechanical coupling coefficient and to make an attenuation coefficient small, it turns out that three conditions of the thickness

of the electrode which consists of a metal of thickness Hs/lambda of the Eulerian angle of LiTaO3 substrate and SiO2 film and the above-mentioned specific consistency, Young's modulus, and the transverse-wave acoustic-velocity range must be taken into consideration.

[0209]

Drawing 90 - drawing 93 show the relation of the theta (degree) and the attenuation coefficient at the time of changing standardization thickness H/lambda of the electrode layer which consists of standardization thickness Hs/lambda and nickel of SiO2 film.

Drawing 94 - drawing 97 show the relation of the theta (degree) and the attenuation coefficient at the time of changing standardization thickness H/lambda of the electrode layer which consists of standardization thickness Hs/lambda and Mo of SiO2 film.

[0210]

In 0.008 to 0.06, 0.017-0.06, and 0.023-0.06, it becomes as standardization thickness H/lambda of the electrode which consists of nickel or Mo shows the thickness of SiO2 film, and the relation with optimal theta in the following table 29, so that clearly from drawing 90 - drawing 97 . In addition, this -2 degrees - about +4 degrees optimal theta may vary by dispersion in the electrode digit of an electrode, or dispersion of a single crystal substrate.

[0211]

Moreover, although **3 degrees phi and psi of an Eulerian angle varied from 0 degree at the time of manufacture, the property as a 0-degree thing that a property is almost the same was acquired.

[0212]

[Table 29]

SiO_2	オイラー角	より好ましいオイラー角
0.1～0.2	(0±3°,105°～140°,0±3°)	(0±3°,110°～135°,0±3°)
0.2～0.3	(0±3°,105°～140°,0±3°)	(0±3°,108°～135°,0±3°)
0.3～0.4	(0±3°,104°～139°,0±3°)	(0±3°,108°～133°,0±3°)

[0213]

Moreover, optimal thickness H/lambda of the electrode which consists of nickel shown by drawing 90 - drawing 93 = the relation between the thickness of SiO2 film in 0.008 to 0.06, 0.02-0.06, and 0.027-0.06 and optimal theta becomes as it is shown in the following table 30.

[0214]
[Table 30]

SiO_2	オイラー角	より好ましいオイラー角
0.1～0.2	(0±3°, 106°～140°, 0±3°)	(0±3°, 110°～135°, 0±3°)
0.2～0.3	(0±3°, 105°～137°, 0±3°)	(0±3°, 108°～134°, 0±3°)
0.3～0.4	(0±3°, 104°～133°, 0±3°)	(0±3°, 108°～132°, 0±3°)

[0215]
Moreover, optimal thickness H/lambda of the electrode which consists of Mo shown in drawing 94 - drawing 97 = the thickness of SiO2 film in 0.008 to 0.06, 0.017-0.06, and 0.023-0.06 and the relation with optimal theta become as they are shown in the following table 31.
[0216]
[Table 31]

SiO_2	オイラー角	より好ましいオイラー角
0.1～0.2	(0±3°, 107°～141°, 0±3°)	(0±3°, 110°～135°, 0±3°)
0.2～0.3	(0±3°, 104°～141°, 0±3°)	(0±3°, 109°～135°, 0±3°)
0.3～0.4	(0±3°, 104°～138°, 0±3°)	(0±3°, 108°～133°, 0±3°)

[0217]
Thickness H/lambda of the electrode which consists of a metal of the above-mentioned specific consistency, Young's modulus, and the transverse-wave acoustic-velocity range so that clearly from Table 29 namely, by 0.008 to 0.06, 0.017-0.06, and 0.023-0.06 In order to improve the frequency temperature characteristic TCF so that it may become within the limits of **20ppm/degree C, when thickness of SiO2 film is made into the range of 0.1-0.4, theta in the Eulerian angle of LiTaO3 It turns out in the range of 104 degrees - 140 degrees, i.e., an angle of rotation, that what is necessary is just to choose the range of 14 degrees - 50 degrees, and the Eulerian angle more preferably shown in Table 29.
[0218]
In order similarly to improve the frequency temperature characteristic TCF so that it may become within the limits of **20ppm/degree C when

standardization thickness H/lambda of the electrode which consists of nickel film is 0.008 to 0.06, 0.02-0.06, and 0.027-0.06 It turns out that theta [in / according to thickness Hs/lambda of SiO2 film of 0.1-0.4 / in Hs/lambda / the Eulerian angle of LiTaO3 substrate] should just choose the range of 104 degrees - 140 degrees, then the Eulerian angle good and shown in Table 30 according to thickness Hs/lambda of SiO2 film more preferably.
[0219]
In order similarly to improve the frequency temperature characteristic TCF so that it may become within the limits of **20ppm/degree C when standardization thickness H/lambda of the electrode which consists of Mo film is 0.008 to 0.06, 0.02-0.06, and 0.027-0.06 It turns out that theta [in / according to thickness Hs/lambda of SiO2 film of 0.1-0.4 / in Hs/lambda / the Eulerian angle of LiTaO3 substrate] should just choose the range of 104 degrees - 141 degrees, then the Eulerian angle good and shown in Table 31 according to thickness Hs/lambda of SiO2 film more preferably.
[0220]
Here, as for the range of "the Eulerian angle of LiTaO3" in Table 29 - 31, an attenuation coefficient alpha specifies the range of 0.1 or less dB/lambda. Moreover, as for the range the Eulerian angle of LiTaO3 in Table 29 - 31 "is more desirable in the range", an attenuation coefficient specifies the range of 0.05 or less dB/lambda. Moreover, it converts and asks for thickness Hs/lambda of SiO2 film in case the standardization thickness of the above-mentioned electrode layer is 0.095, 0.017, and 0.023, and the relation of an Eulerian angle from the standardization thickness of the electrode layer which consists of nickel or Mo shown in drawing 90 - drawing 97 , and they are calculating the thickness of SiO2 film of Table 29 - 31, and the value of an Eulerian angle by it.
[0221]
After forming IDT which consists of the above-mentioned specific metal of nickel, Mo, etc. on rotation Y cut X propagation LiTaO3 substrate on the occasion of manufacture of the surface acoustic wave equipment concerning this invention, it is desirable to form SiO2 film of the thickness of the range which performs frequency regulation in the condition and can make an attenuation coefficient alpha small after an appropriate time. This is explained with reference to drawing 98 - Fig. 101 . Drawing 98 and drawing 100 show change of the acoustic velocity of the leakage surface acoustic wave at the time of forming SiO2 film of IDT which consists of nickel or Mo of various thickness H/lambda, and

various thickness Hs/lambda on the rotation Y cut X propagation $LiTaO_3$ substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree). Moreover, drawing 99 and drawing 101 show change of the acoustic velocity of the leakage surface acoustic wave at the time of changing standardization thickness Hs/lambda of SiO_2 film formed on it, when IDT which consists of nickel or Mo of various thickness H/lambda is formed on the $LiTaO_3$ substrate of the same Eulerian angle. If drawing 98 , drawing 99 , and drawing 100 and drawing 101 are compared, change of the acoustic velocity of a surface acoustic wave is far larger than the case where the direction at the time of changing the thickness of an electrode changes the thickness of SiO_2 film so that clearly. Therefore, it is desirable to perform frequency regulation in advance of formation of SiO_2 film, for example, after forming IDT which consists of nickel or Mo by laser etching, ion etching, etc., it is desirable to perform frequency regulation.
[0222]
In addition, the piezo-electric substrate with which this invention consists of $LiTaO_3$ of (0 degree, 104 degrees - 140 degrees, 0 degree) as mentioned above by 14 degrees - 50 degree rotation Y cut X propagation and the Eulerian angle, H/lambda = IDT which consists of a metal of the above-mentioned specific consistency of nickel, Mo, etc. which are 0.008-0.06, Young's modulus, and the transverse-wave acoustic-velocity range, Hs/lambda = it is not characterized by having SiO_2 film which is 0.10-0.40, and is not limited [therefore] especially about a number, structure, etc. of IDT. That is, this invention is applicable to various surface acoustic wave resonators, a surface acoustic wave filter, etc., as long as not only the surface acoustic wave equipment shown in drawing 15 but the above-mentioned conditions are fulfilled.
[0223]
[Effect of the Invention]
In the remaining fields except the field in which the IDT electrode is formed with the surface acoustic wave equipment concerning the 1st invention In the configuration in which the 1st insulating material layer which was in an IDT electrode, abbreviation, etc. by carrying out, and was formed in thickness is prepared, and the 2nd insulating material layer is prepared so that an IDT electrode and the 1st insulating material layer may be covered Since an IDT electrode consists of an alloy which uses the metal or this metal of high density as a principal component rather than the consistency of the 1st insulating material layer, the reflection coefficient of an IDT electrode can be made into sufficient magnitude. Therefore, the good surface acoustic wave

equipment of the frequency temperature characteristic which degradation of the property by the ripple which is not a request cannot produce easily can be offered.
[0224]
In addition, since an IDT electrode and the 1st insulating material layer are in abbreviation etc. by carrying out, and it considers as thickness, and the laminating of the 2nd insulating material layer is carried out so that an IDT electrode and the 1st insulating material layer may be covered, flattening of the outside surface of the 2nd insulating material layer can be carried out, and it is hard to produce degradation of the property by the irregularity of the 2nd insulating material layer front face by it.
[0225]
With the surface acoustic wave equipment concerning the 2nd invention, the 1st insulating material layer of thickness almost equal to an IDT electrode is prepared in the remaining fields except the field in which the IDT electrode is formed, the protection metal membrane which consists of a metal or an alloy excellent in corrosion resistance is prepared on the IDT electrode rather than the metal or the alloy which constitutes an IDT electrode, and the 2nd insulating material layer is formed so that the protection metal membrane and 1st insulating material layer top may be covered. Therefore, since the IDT electrode is covered with the protection metal layer and the 1st insulating material layer, it is hard to produce the corrosion of an IDT electrode with the resist exfoliation liquid at the time of exfoliating a resist with a photolithography technique. Therefore, although it is easy to be corroded by resist exfoliation liquid, such as Cu, a consistency can constitute an IDT electrode using sufficiently big metal or alloy compared with aluminum, and can control degradation of the property of surface acoustic wave equipment effectively.
[0226]
In the 1st and 2nd invention, when the 1st and 2nd insulating material layer is constituted by SiO_2, according to this invention, the surface acoustic wave equipment with which the frequency temperature characteristic TCF has been improved can be offered.
[0227]
When an IDT electrode consists of an alloy which uses Cu or Cu as a principal component, compared with aluminum used widely as an electrode material of surface acoustic wave equipment from the former, the surface acoustic wave equipment which followed the 1st and 2nd invention since the consistency was large can be constituted easily, and the IDT

electrode of sufficient reflection coefficient can be formed easily.
[0228]
By the manufacture approach concerning the 3rd invention, after forming the 1st insulating material layer in the piezoelectric substrate 2 The insulating material layer of the part in which an IDT electrode is formed using a resist pattern is removed. The laminated structure of the 1st insulating material layer and a resist remains to the remaining fields. Next By forming the electrode layer which uses the metal or this metal of high density as a principal component rather than aluminum in the field to which the 1st insulating material layer is removed, an IDT electrode is formed and the resist which remains on the 1st insulating material layer is removed after an appropriate time. And since the 2nd insulating material layer is formed so that a 1st insulating material layer and IDT electrode top may be covered, it is hard to produce the irregularity on the top face of the 2nd insulating material layer. Therefore, it is hard to produce degradation of the property by the irregularity of the 2nd insulating material layer front face. In addition, since an IDT electrode consists of an alloy which uses the metal or this metal of high density as a principal component rather than aluminum, the reflection coefficient of an IDT electrode is raised and degradation of the property by the ripple which is not a request can be controlled.
[0229]
Moreover, according to the 4th invention, after forming an IDT electrode, the protection metal membrane which consists of a metal or an alloy excellent in corrosion resistance is formed, and the protection metal membrane by which the laminating is carried out on the resist on the 1st insulating material layer and this resist is removed from the metal or alloy which constitutes an IDT electrode after an appropriate time. Therefore, since it faces that resist exfoliation liquid performs this removal process, and the side face of an IDT electrode is covered with the 1st insulating material layer and the top face is covered with the protection metal layer, it is hard to produce the corrosion of an IDT electrode.
[0230]
Therefore, it becomes possible to offer the surface acoustic wave equipment concerning the 2nd invention, without causing the corrosion of an IDT electrode.
According to the 5th invention, after forming an electrode on a piezo-electric substrate, and forming an insulating material layer so that this electrode may be covered, flattening of the irregularity of the

front face of the insulating material layer above the part in which an electrode exists, and the part not existing is carried out. Therefore, it is hard to produce degradation of the property by the irregularity of an insulating material layer front face like the 1st invention.

[Brief Description of the Drawings]

[Drawing 1] (a) - (g) is each typical partial notching sectional view for explaining the manufacture approach of the surface acoustic wave equipment in one example of this invention.

[Drawing 2] Drawing showing the relation between the electrode layer thickness when having not carried out flattening to the case where flattening of the front face of SiO2 film is carried out, in 1 port mold surface acoustic wave resonator to which the IDT electrode which consists of aluminum, Au, or Pt by various thickness is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), and standardization thickness Hs/lambda comes to form SiO2 film of 0.2 further, and a reflection coefficient.

[Drawing 3] Drawing showing the relation between the electrode layer thickness when having not carried out flattening to the case where flattening of the front face of SiO2 film is carried out, in 1 port mold surface acoustic wave resonator to which the IDT electrode which consists of aluminum, Cu, or Ag by various thickness is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), and standardization thickness Hs/lambda comes to form SiO2 film of 0.2 further, and a reflection coefficient.

[Drawing 4] Drawing showing the relation between the standardization thickness of SiO2 film of the surface acoustic wave resonator obtained by the manufacture approach of the example of a comparison, and a phase characteristic and an impedance characteristic.

[Drawing 5] Drawing showing the relation between the thickness of SiO2 film in the surface acoustic wave resonator prepared for the comparison, and MF of a resonator.

[Drawing 6] The typical top view of 1 port mold surface acoustic wave resonator obtained in the one example of this invention.

[Drawing 7] Drawing showing change of the impedance characteristic at the time of changing the standardization thickness of SiO2 film, and a phase characteristic in the manufacture approach of an example.

[Drawing 8] Drawing showing the relation of the thickness of SiO2 film and gamma of a resonator in the surface acoustic wave resonator obtained by the manufacture approach of an example and the example of a comparison.

[Drawing 9] Drawing showing the relation of the thickness of SiO2 film

and MF of a resonator in the surface acoustic wave resonator obtained by the manufacture approach of an example and the example of a comparison.
[Drawing 10] Drawing showing the relation between the thickness of SiO_2 film in the surface acoustic wave resonator prepared in the example and the example of a comparison, and change of the frequency temperature characteristic TCF.
[Drawing 11] Drawing showing the impedance-frequency characteristics which do not have SiO_2 film with the surface acoustic wave resonator in which SiO_2 film prepared in the 2nd example of a comparison was formed.
[Drawing 12] (a) - (e) is drawing showing change of the impedance characteristic at the time of changing the ratio to the consistency of the 1st insulating material layer of the mean density of an IDT electrode and a protection metal membrane.
[Drawing 13] Drawing showing change of the electromechanical coupling coefficient at the time of forming the IDT electrode which consists of various metals by various thickness on the $LiTaO_3$ substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree).
[Drawing 14] Drawing showing relation with the consistency of the electrode layer Atsunori enclosure and electrode material with which an electromechanical coupling coefficient becomes large compared with the case where the electrode which consists of aluminum is used when an IDT electrode is formed with various metals on $LiTaO_3$ substrate.
[Drawing 15] The perspective view showing the surface acoustic wave equipment concerning other examples of this invention.
[Drawing 16] Drawing showing the relation of the electrode layer thickness and the electromechanical coupling coefficient by which IDT at the time of forming IDT which consists of IDT and aluminum which consist of Au, Ta, Ag, Cr, W, Cu, Zn, Mo, and nickel on the $LiTaO_3$ substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle) was standardized.
[Drawing 17] 36-degree rotation Y cut X propagation (drawing showing the reflection coefficient of electrode finger one of the two of IDT and the relation of thickness it is unrelated from various electrode materials on the $LiTaO_3$ substrate of (0 degree, 126 degrees, 0 degree) by the Eulerian angle.)
[Drawing 18] Drawing showing the relation between the electrode standardization thickness of IDT at the time of forming IDT which consists of IDT and aluminum which consist of Au, Ta, Ag, Cr, W, Cu, Zn, Mo, and nickel on the $LiTaO_3$ substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle), and an attenuation coefficient.

[Drawing 19] Drawing showing change of the frequency temperature characteristic (TCF) when standardization thickness forms IDT which consists of Au which is 0.02 and forms SiO2 film of various thickness on the LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle).
[Drawing 20] Drawing showing change of the attenuation coefficient alpha at the time of changing the SiO2 film standardization thickness which forms IDT which consists of Au of various thickness on the LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle), and turns a laminating up further.
[Drawing 21] Drawing showing change of the attenuation coefficient alpha at the time of changing the SiO2 film standardization thickness which forms IDT which consists of Au of various thickness on the LiTaO3 substrate of 38-degree rotation Y cut X propagation (they are (0 degree, 128 degrees, 0 degree) at an Eulerian angle), and turns a laminating up further.
[Drawing 22] Drawing showing the magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment for the comparison before the magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment of an example, and SiO2 film membrane formation.
[Drawing 23] Drawing showing change of the acoustic velocity of the leakage surface acoustic wave at the time of changing the standardization thickness of IDT which consists of Au in the structure which formed IDT which consists of Au and formed SiO2 film of various thickness on the LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle).
[Drawing 24] Drawing showing change of the acoustic velocity of the leakage surface acoustic wave at the time of changing the standardization thickness of SiO2 film in the structure which formed IDT which consists of Au of various standardization thickness on the LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle), and was further made into the SiO2 film laminating.
[Drawing 25] Drawing showing change of the electromechanical coupling coefficient at the time of changing the standardization thickness of IDT which consists of theta of (0 degree, theta, 0 degree), and Au by the Eulerian angle, and the standardization thickness of SiO2 film.
[Drawing 26] Drawing showing change of the Q value of the resonator at

the time of changing theta of the Eulerian angle of LiTaO3 substrate, and the standardization thickness of SiO2 film.
[Drawing 27] (a) - (c) is each typical sectional view for explaining the surface acoustic wave equipment concerning the modification of this invention in which the adhesion layer was prepared.
[Drawing 28] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.1.
[Drawing 29] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.15.
[Drawing 30] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.2.
[Drawing 31] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.25.
[Drawing 32] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.3.
[Drawing 33] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.35.
[Drawing 34] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.4.
[Drawing 35] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.45.
[Drawing 36] Drawing showing relation with an electromechanical coupling coefficient Ksaw with standardization thickness H/lambda of Ag film at the time of forming the electrode which consists of Ag film of various thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree).
[Drawing 37] an Eulerian angle (0 degree, 113 degrees, 0 degree) -- and (0 degree, 126 degrees, 0 degree) (0 degree, 129 degrees, 0 degree) drawing showing the relation between standardization thickness Hs/lambda of SiO2 film when electrode layer thickness forms SiO2 film of various thickness by 0, and the frequency temperature coefficient TCF in three kinds of LiTaO3 substrates.
[Drawing 38] Drawing showing change of the attenuation coefficient alpha

at the time of forming Ag film of 0.1 or less standardization thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree), and forming SiO2 film of the standardization thickness of 0-0.5.
[Drawing 39] Drawing showing change of the attenuation coefficient alpha at the time of forming Ag film of 0.1 or less standardization thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree), and forming SiO2 film of the standardization thickness of 0-0.5.
[Drawing 40] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.1.
[Drawing 41] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.15.
[Drawing 42] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.2.
[Drawing 43] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.25.
[Drawing 44] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.3.
[Drawing 45] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.35.
[Drawing 46] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the

laminating of the SiO2 film of 0.4.
[Drawing 47] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.45.
[Drawing 48] Drawing showing change of the attenuation coefficient alpha at the time of forming Cu film of 0.1 or less standardization thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree), and forming SiO2 film of the standardization thickness of 0-0.5.
[Drawing 49] Drawing showing change of the attenuation coefficient alpha at the time of forming Cu film of 0.1 or less standardization thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 135 degrees, 0 degree), and forming SiO2 film of the standardization thickness of 0-0.5.
[Drawing 50] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.1.
[Drawing 51] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.15.
[Drawing 52] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.2.
[Drawing 53] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.25.
[Drawing 54] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.3.
[Drawing 55] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu

film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.35.
[Drawing 56] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.4.
[Drawing 57] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.45.
[Drawing 58] Drawing showing the relation of the reflection factor per electrode finger and electrode layer thickness in the electrode which consists of an electrode which consists of aluminum in case the standardization thickness of SiO2 film is 0.02, and Cu.
[Drawing 59] Drawing showing the relation between standardization thickness Hs/lambda of SiO2 film for realizing thetamin from which an attenuation coefficient serves as 0 or min, and standardization thickness H/lambda of Cu film.
[Drawing 60] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and a tungsten of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree).
[Drawing 61] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and a tungsten of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 62] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tungsten of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tungsten.
[Drawing 63] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tungsten of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree),

and standardization thickness H/lambda of the electrode layer which consists of a tungsten.

[Drawing 64] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tungsten of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tungsten.

[Drawing 65] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tungsten of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tungsten.

[Drawing 66] Drawing showing the thickness of the tungsten film at the time of forming IDT which consists of a tungsten and forming SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), the thickness of SiO2 film, and relation with acoustic velocity.

[Drawing 67] Drawing showing the thickness of the tungsten film at the time of forming IDT which consists of a tungsten and forming SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), the thickness of SiO2 film, and relation with acoustic velocity.

[Drawing 68] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of a tantalum of SiO2 film of various thickness and various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree).

[Drawing 69] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of a tantalum of SiO2 film of various thickness and various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).

[Drawing 70] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tantalum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tantalum.

[Drawing 71] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tantalum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tantalum.
[Drawing 72] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tantalum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tantalum.
[Drawing 73] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tantalum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tantalum.
[Drawing 74] Drawing showing relation with acoustic velocity with the standardization thickness of a tantalum in the structure which formed IDT which consists of a tantalum on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), and formed SiO2 film on it, and the standardization thickness of SiO2.
[Drawing 75] Drawing showing relation with acoustic velocity with the standardization thickness of a tantalum in the structure where IDT which consists of a tantalum is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), and SiO2 film was formed on it, and the standardization thickness of SiO2.
[Drawing 76] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and platinum of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 125 degrees, 0 degree).
[Drawing 77] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and platinum of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 78] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the

electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 79] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.15 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 80] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 81] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.25 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 82] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 83] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 84] Drawing showing the thickness of the platinum film at the

time of forming IDT which consists of platinum and forming SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), the thickness of SiO2 film, and relation with acoustic velocity.
[Drawing 85] Drawing showing the thickness of the platinum film at the time of forming IDT which consists of platinum and forming SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), the thickness of SiO2 film, and relation with acoustic velocity.
[Drawing 86] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and nickel of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree).
[Drawing 87] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and nickel of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 88] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and molybdenum of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree).
[Drawing 89] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and molybdenum of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 90] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of nickel of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of nickel.
[Drawing 91] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of nickel of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of nickel.
[Drawing 92] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the

electrode layer which consists of nickel of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of nickel.

[Drawing 93] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of nickel of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of nickel.

[Drawing 94] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of molybdenum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of molybdenum.

[Drawing 95] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of molybdenum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of molybdenum.

[Drawing 96] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of molybdenum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of molybdenum.

[Drawing 97] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of molybdenum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of molybdenum.

[Drawing 98] Drawing showing the thickness of the nickel film when IDT

which consists of nickel is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree) and SiO2 film of still more various thickness is formed, the thickness of the nickel film, and relation with acoustic velocity.
[Drawing 99] Drawing in which forming IDT which consists of nickel of various thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), forming SiO2 film on it, and showing the thickness of SiO2 film in structure, and relation with acoustic velocity.
[Drawing 100] Drawing showing relation with acoustic velocity with the standardization thickness of the molybdenum in structure when IDT which becomes since it consists of molybdenum is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree) and SiO2 film of various thickness is formed on it.
[Drawing 101] Drawing showing relation with acoustic velocity with the standardization thickness of SiO2 film in the structure which formed IDT which consists of molybdenum of various thickness, and formed SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree).
[Drawing 102] (a) - (c) is each typical sectional view for explaining the etchback method as an example of an approach which attains flattening of an insulating material layer front face.
[Drawing 103] (a) - (d) is each typical sectional view for explaining the reverse spatter as other examples of the approach of carrying out flattening of the insulating material layer front face.
[Drawing 104] (a) And (b) is the typical sectional view showing the example of further others of the approach of carrying out flattening of the insulating material layer front face.
[Drawing 105] (a) - (c) is each typical sectional view for explaining an option to the pan which carries out flattening of the insulating material layer front face.
[Drawing 106] (a) And (b) is each typical top view for explaining 1 port mold resonator as an example of surface acoustic wave equipment and 2 port mold resonator to which this invention is applied.
[Drawing 107] The typical top view for explaining the ladder mold filter as surface acoustic wave equipment with which this invention is applied.
[Drawing 108] The typical top view for explaining the lattice mold filter as surface acoustic wave equipment with which this invention is applied.
[Drawing 109] (a) - (d) is a typical sectional view to show an example of the manufacture approach of conventional surface acoustic wave equipment.

[Drawing 110] The typical transverse-plane sectional view for explaining an example of conventional surface acoustic wave equipment. .
[Description of Notations]
1 -- LiTaO3 substrate
2 -- The 1st insulating material layer
3 -- Resist pattern
4 -- Metal membrane
Four A--IDT electrodes
5 -- Ti film as a protection metal membrane
6 -- The 2nd insulating material layer
11 -- Surface acoustic wave resonator
12 13 -- Reflector
21 -- Surface acoustic wave equipment
22 -- LiTaO3 substrate
23a, 23 b--IDT
25 -- SiO2 film

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a) - (g) is each typical partial notching sectional view for explaining the manufacture approach of the surface acoustic wave equipment in one example of this invention.
[Drawing 2] Drawing showing the relation between the electrode layer thickness when having not carried out flattening to the case where flattening of the front face of SiO2 film is carried out, in 1 port mold surface acoustic wave resonator to which the IDT electrode which consists of aluminum, Au, or Pt by various thickness is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree),

and standardization thickness Hs/lambda comes to form SiO2 film of 0.2 further, and a reflection coefficient.

[Drawing 3] Drawing showing the relation between the electrode layer thickness when having not carried out flattening to the case where flattening of the front face of SiO2 film is carried out, in 1 port mold surface acoustic wave resonator to which the IDT electrode which consists of aluminum, Cu, or Ag by various thickness is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), and standardization thickness Hs/lambda comes to form SiO2 film of 0.2 further, and a reflection coefficient.

[Drawing 4] Drawing showing the relation between the standardization thickness of SiO2 film of the surface acoustic wave resonator obtained by the manufacture approach of the example of a comparison, and a phase characteristic and an impedance characteristic.

[Drawing 5] Drawing showing the relation between the thickness of SiO2 film in the surface acoustic wave resonator prepared for the comparison, and MF of a resonator.

[Drawing 6] The typical top view of 1 port mold surface acoustic wave resonator obtained in the one example of this invention.

[Drawing 7] Drawing showing change of the impedance characteristic at the time of changing the standardization thickness of SiO2 film, and a phase characteristic in the manufacture approach of an example.

[Drawing 8] Drawing showing the relation of the thickness of SiO2 film and gamma of a resonator in the surface acoustic wave resonator obtained by the manufacture approach of an example and the example of a comparison.

[Drawing 9] Drawing showing the relation of the thickness of SiO2 film and MF of a resonator in the surface acoustic wave resonator obtained by the manufacture approach of an example and the example of a comparison.

[Drawing 10] Drawing showing the relation between the thickness of SiO2 film in the surface acoustic wave resonator prepared in the example and the example of a comparison, and change of the frequency temperature characteristic TCF.

[Drawing 11] Drawing showing the impedance-frequency characteristics which do not have SiO2 film with the surface acoustic wave resonator in which SiO2 film prepared in the 2nd example of a comparison was formed.

[Drawing 12] (a) - (e) is drawing showing change of the impedance characteristic at the time of changing the ratio to the consistency of the 1st insulating material layer of the mean density of an IDT electrode and a protection metal membrane.

[Drawing 13] Drawing showing change of the electromechanical coupling

coefficient at the time of forming the IDT electrode which consists of various metals by various thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree).
[Drawing 14] Drawing showing relation with the consistency of the electrode layer Atsunori enclosure and electrode material with which an electromechanical coupling coefficient becomes large compared with the case where the electrode which consists of aluminum is used when an IDT electrode is formed with various metals on LiTaO3 substrate.
[Drawing 15] The perspective view showing the surface acoustic wave equipment concerning other examples of this invention.
[Drawing 16] Drawing showing the relation of the electrode layer thickness and the electromechanical coupling coefficient by which IDT at the time of forming IDT which consists of IDT and aluminum which consist of Au, Ta, Ag, Cr, W, Cu, Zn, Mo, and nickel on the LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle) was standardized.
[Drawing 17] 36-degree rotation Y cut X propagation (drawing showing the reflection coefficient of electrode finger one of the two of IDT and the relation of thickness it is unrelated from various electrode materials on the LiTaO3 substrate of (0 degree, 126 degrees, 0 degree) by the Eulerian angle.)
[Drawing 18] Drawing showing the relation between the electrode standardization thickness of IDT at the time of forming IDT which consists of IDT and aluminum which consist of Au, Ta, Ag, Cr, W, Cu, Zn, Mo, and nickel on the LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle), and an attenuation coefficient.
[Drawing 19] Drawing showing change of the frequency temperature characteristic (TCF) when standardization thickness forms IDT which consists of Au which is 0.02 and forms SiO2 film of various thickness on the LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle).
[Drawing 20] Drawing showing change of the attenuation coefficient alpha at the time of changing the SiO2 film standardization thickness which forms IDT which consists of Au of various thickness on the LiTaO3 substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle), and turns a laminating up further.
[Drawing 21] Drawing showing change of the attenuation coefficient alpha at the time of changing the SiO2 film standardization thickness which forms IDT which consists of Au of various thickness on the LiTaO3

substrate of 38-degree rotation Y cut X propagation (they are (0 degree, 128 degrees, 0 degree) at an Eulerian angle), and turns a laminating up further.

[Drawing 22] Drawing showing the magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment for the comparison before the magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment of an example, and SiO_2 film membrane formation.

[Drawing 23] Drawing showing change of the acoustic velocity of the leakage surface acoustic wave at the time of changing the standardization thickness of IDT which consists of Au in the structure which formed IDT which consists of Au and formed SiO_2 film of various thickness on the $LiTaO_3$ substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle).

[Drawing 24] Drawing showing change of the acoustic velocity of the leakage surface acoustic wave at the time of changing the standardization thickness of SiO_2 film in the structure which formed IDT which consists of Au of various standardization thickness on the $LiTaO_3$ substrate of 36-degree rotation Y cut X propagation (they are (0 degree, 126 degrees, 0 degree) at an Eulerian angle), and was further made into the SiO_2 film laminating.

[Drawing 25] Drawing showing change of the electromechanical coupling coefficient at the time of changing the standardization thickness of IDT which consists of theta of (0 degree, theta, 0 degree), and Au by the Eulerian angle, and the standardization thickness of SiO_2 film.

[Drawing 26] Drawing showing change of the Q value of the resonator at the time of changing theta of the Eulerian angle of $LiTaO_3$ substrate, and the standardization thickness of SiO_2 film.

[Drawing 27] (a) - (c) is each typical sectional view for explaining the surface acoustic wave equipment concerning the modification of this invention in which the adhesion layer was prepared.

[Drawing 28] Thickness H/lambda of SiO_2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.1.

[Drawing 29] Thickness H/lambda of SiO_2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.15.

[Drawing 30] Thickness H/lambda of SiO_2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.2.

[Drawing 31] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.25.
[Drawing 32] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.3.
[Drawing 33] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.35.
[Drawing 34] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.4.
[Drawing 35] Thickness H/lambda of SiO2 film = drawing showing the relation of the attenuation coefficients alpha and theta in various Au electrode layer thickness in 0.45.
[Drawing 36] Drawing showing relation with an electromechanical coupling coefficient Ksaw with standardization thickness H/lambda of Ag film at the time of forming the electrode which consists of Ag film of various thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree).
[Drawing 37] an Eulerian angle (0 degree, 113 degrees, 0 degree) -- and (0 degree, 126 degrees, 0 degree) (0 degree, 129 degrees, 0 degree) drawing showing the relation between standardization thickness Hs/lambda of SiO2 film when electrode layer thickness forms SiO2 film of various thickness by 0, and the frequency temperature coefficient TCF in three kinds of LiTaO3 substrates.
[Drawing 38] Drawing showing change of the attenuation coefficient alpha at the time of forming Ag film of 0.1 or less standardization thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree), and forming SiO2 film of the standardization thickness of 0-0.5.
[Drawing 39] Drawing showing change of the attenuation coefficient alpha at the time of forming Ag film of 0.1 or less standardization thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree), and forming SiO2 film of the standardization thickness of 0-0.5.
[Drawing 40] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.1.
[Drawing 41] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag

film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.15.
[Drawing 42] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.2.
[Drawing 43] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.25.
[Drawing 44] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.3.
[Drawing 45] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.35.
[Drawing 46] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.4.
[Drawing 47] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Ag film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.45.
[Drawing 48] Drawing showing change of the attenuation coefficient alpha at the time of forming Cu film of 0.1 or less standardization thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree), and forming SiO2 film of the standardization thickness of 0-0.5.
[Drawing 49] Drawing showing change of the attenuation coefficient alpha at the time of forming Cu film of 0.1 or less standardization thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 135 degrees, 0 degree), and forming SiO2 film of the standardization thickness of 0-0.5.

[Drawing 50] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.1.
[Drawing 51] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.15.
[Drawing 52] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.2.
[Drawing 53] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.25.
[Drawing 54] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.3.
[Drawing 55] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.35.
[Drawing 56] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.4.
[Drawing 57] Drawing showing change of an attenuation coefficient alpha when standardization thickness H/lambda forms 0.1 or less various Cu film on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree) and standardization thickness Hs/lambda carries out the laminating of the SiO2 film of 0.45.
[Drawing 58] Drawing showing the relation of the reflection factor per

electrode finger and electrode layer thickness in the electrode which consists of an electrode which consists of aluminum in case the standardization thickness of SiO_2 film is 0.02, and Cu.
[Drawing 59] Drawing showing the relation between standardization thickness Hs/lambda of SiO_2 film for realizing thetamin from which an attenuation coefficient serves as 0 or min, and standardization thickness H/lambda of Cu film.
[Drawing 60] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO_2 film of various thickness and a tungsten of various thickness was formed on the $LiTaO_3$ substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree).
[Drawing 61] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO_2 film of various thickness and a tungsten of various thickness was formed on the $LiTaO_3$ substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 62] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tungsten of various thickness, and formed SiO_2 film of standardization thickness Hs/lambda =0.1 further on the $LiTaO_3$ substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tungsten.
[Drawing 63] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tungsten of various thickness, and formed SiO_2 film of standardization thickness Hs/lambda =0.2 further on the $LiTaO_3$ substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tungsten.
[Drawing 64] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tungsten of various thickness, and formed SiO_2 film of standardization thickness Hs/lambda =0.3 further on the $LiTaO_3$ substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tungsten.
[Drawing 65] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tungsten of various thickness, and formed SiO_2 film of standardization thickness Hs/lambda =0.4 further on the $LiTaO_3$ substrate of an Eulerian angle (0 degree, theta, 0 degree),

and standardization thickness H/lambda of the electrode layer which consists of a tungsten.
[Drawing 66] Drawing showing the thickness of the tungsten film at the time of forming IDT which consists of a tungsten and forming SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), the thickness of SiO2 film, and relation with acoustic velocity.
[Drawing 67] Drawing showing the thickness of the tungsten film at the time of forming IDT which consists of a tungsten and forming SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), the thickness of SiO2 film, and relation with acoustic velocity.
[Drawing 68] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of a tantalum of SiO2 film of various thickness and various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree).
[Drawing 69] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of a tantalum of SiO2 film of various thickness and various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 70] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tantalum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tantalum.
[Drawing 71] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tantalum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tantalum.
[Drawing 72] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tantalum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tantalum.

[Drawing 73] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of a tantalum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of a tantalum.
[Drawing 74] Drawing showing relation with acoustic velocity with the standardization thickness of a tantalum in the structure which formed IDT which consists of a tantalum on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), and formed SiO2 film on it, and the standardization thickness of SiO2.
[Drawing 75] Drawing showing relation with acoustic velocity with the standardization thickness of a tantalum in the structure where IDT which consists of a tantalum is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), and SiO2 film was formed on it, and the standardization thickness of SiO2.
[Drawing 76] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and platinum of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 125 degrees, 0 degree).
[Drawing 77] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and platinum of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 78] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 79] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.15 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 80] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the

electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 81] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.25 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 82] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 83] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of platinum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of platinum.
[Drawing 84] Drawing showing the thickness of the platinum film at the time of forming IDT which consists of platinum and forming SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), the thickness of SiO2 film, and relation with acoustic velocity.
[Drawing 85] Drawing showing the thickness of the platinum film at the time of forming IDT which consists of platinum and forming SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), the thickness of SiO2 film, and relation with acoustic velocity.
[Drawing 86] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and nickel of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree).
[Drawing 87] Drawing showing change of the attenuation coefficient alpha

in the structure in which IDT which consists of SiO2 film of various thickness and nickel of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 88] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and molybdenum of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 120 degrees, 0 degree).
[Drawing 89] Drawing showing change of the attenuation coefficient alpha in the structure in which IDT which consists of SiO2 film of various thickness and molybdenum of various thickness was formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 140 degrees, 0 degree).
[Drawing 90] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of nickel of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of nickel.
[Drawing 91] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of nickel of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of nickel.
[Drawing 92] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of nickel of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of nickel.
[Drawing 93] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of nickel of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of nickel.
[Drawing 94] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the

electrode layer which consists of molybdenum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.1 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of molybdenum.
[Drawing 95] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of molybdenum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.2 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of molybdenum.
[Drawing 96] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of molybdenum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.3 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of molybdenum.
[Drawing 97] Drawing showing relation with an attenuation coefficient alpha with theta in the surface acoustic wave equipment which formed the electrode layer which consists of molybdenum of various thickness, and formed SiO2 film of standardization thickness Hs/lambda =0.4 further on the LiTaO3 substrate of an Eulerian angle (0 degree, theta, 0 degree), and standardization thickness H/lambda of the electrode layer which consists of molybdenum.
[Drawing 98] Drawing showing the thickness of the nickel film when IDT which consists of nickel is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree) and SiO2 film of still more various thickness is formed, the thickness of the nickel film, and relation with acoustic velocity.
[Drawing 99] Drawing in which forming IDT which consists of nickel of various thickness on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree), forming SiO2 film on it, and showing the thickness of SiO2 film in structure, and relation with acoustic velocity.
[Drawing 100] Drawing showing relation with acoustic velocity with the standardization thickness of the molybdenum in structure when IDT which becomes since it consists of molybdenum is formed on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree) and SiO2 film of various thickness is formed on it.
[Drawing 101] Drawing showing relation with acoustic velocity with the

standardization thickness of SiO2 film in the structure which formed IDT which consists of molybdenum of various thickness, and formed SiO2 film further on the LiTaO3 substrate of an Eulerian angle (0 degree, 126 degrees, 0 degree).
[Drawing 102] (a) - (c) is each typical sectional view for explaining the etchback method as an example of an approach which attains flattening of an insulating material layer front face.
[Drawing 103] (a) - (d) is each typical sectional view for explaining the reverse spatter as other examples of the approach of carrying out flattening of the insulating material layer front face.
[Drawing 104] (a) And (b) is the typical sectional view showing the example of further others of the approach of carrying out flattening of the insulating material layer front face.
[Drawing 105] (a) - (c) is each typical sectional view for explaining an option to the pan which carries out flattening of the insulating material layer front face.
[Drawing 106] (a) And (b) is each typical top view for explaining 1 port mold resonator as an example of surface acoustic wave equipment and 2 port mold resonator to which this invention is applied.
[Drawing 107] The typical top view for explaining the ladder mold filter as surface acoustic wave equipment with which this invention is applied.
[Drawing 108] The typical top view for explaining the lattice mold filter as surface acoustic wave equipment with which this invention is applied.
[Drawing 109] (a) - (d) is a typical sectional view to show an example of the manufacture approach of conventional surface acoustic wave equipment.
[Drawing 110] The typical transverse-plane sectional view for explaining an example of conventional surface acoustic wave equipment. .
[Description of Notations]
1 -- LiTaO3 substrate
2 -- The 1st insulating material layer
3 -- Resist pattern
4 -- Metal membrane
Four A--IDT electrodes
5 -- Ti film as a protection metal membrane
6 -- The 2nd insulating material layer
11 -- Surface acoustic wave resonator
12 13 -- Reflector
21 -- Surface acoustic wave equipment
22 -- LiTaO3 substrate

23a, 23 b--IDT
25 -- SiO2 film

[Translation done.]

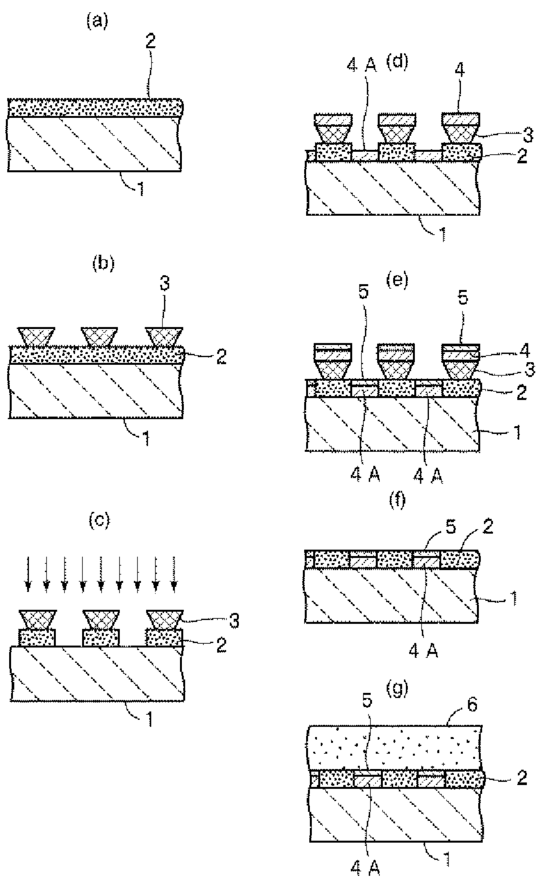
* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

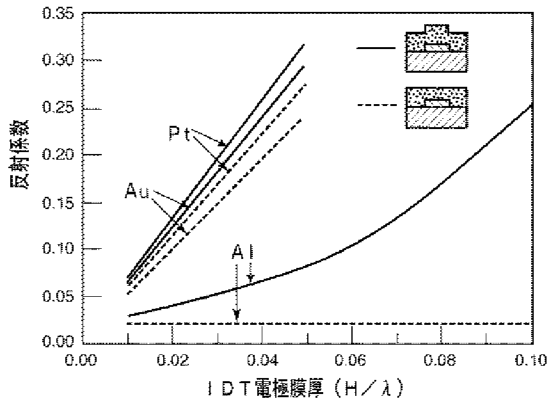
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

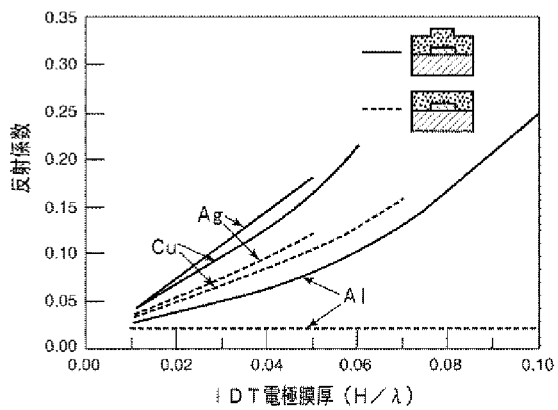
[Drawing 1]



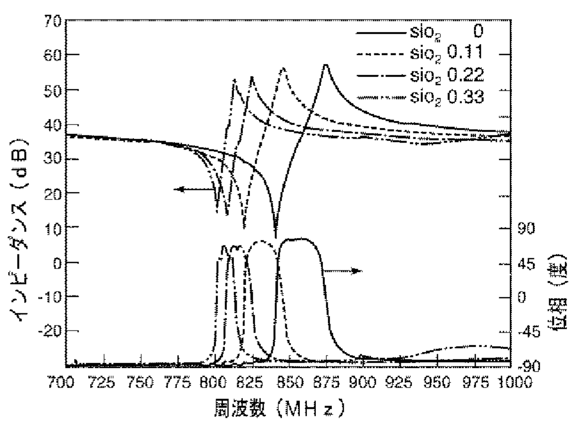
[Drawing 2]



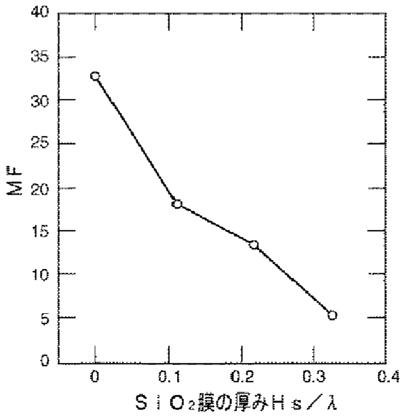
[Drawing 3]



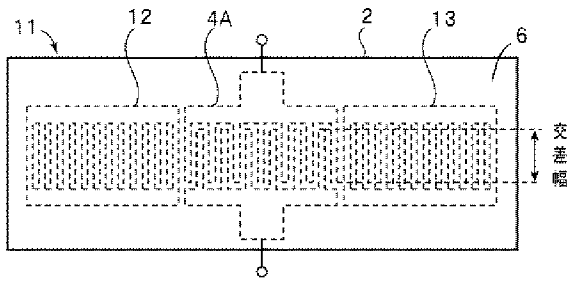
[Drawing 4]



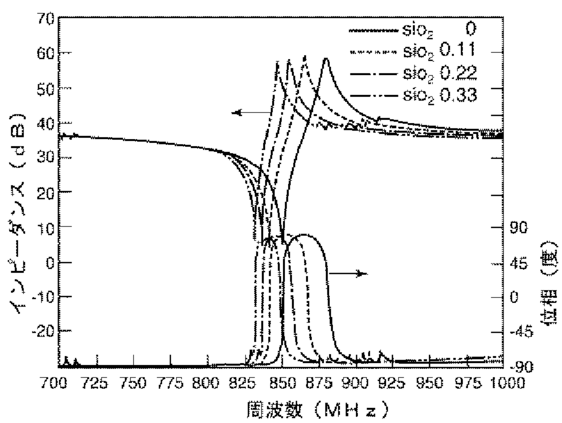
[Drawing 5]



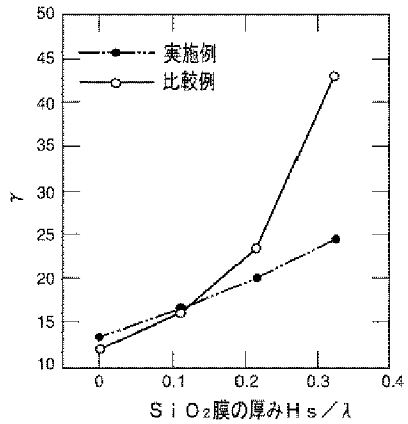
[Drawing 6]



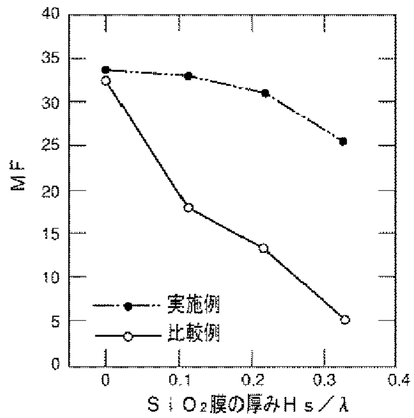
[Drawing 7]



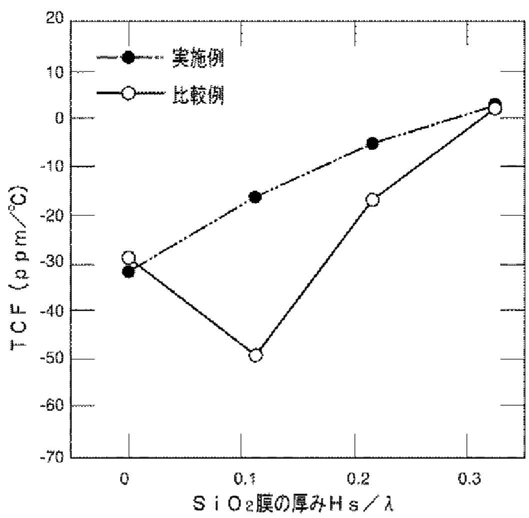
[Drawing 8]



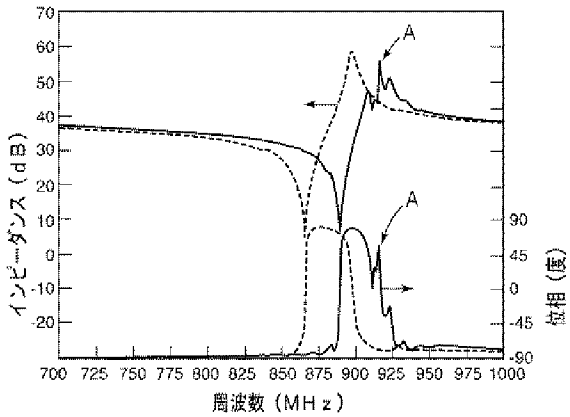
[Drawing 9]



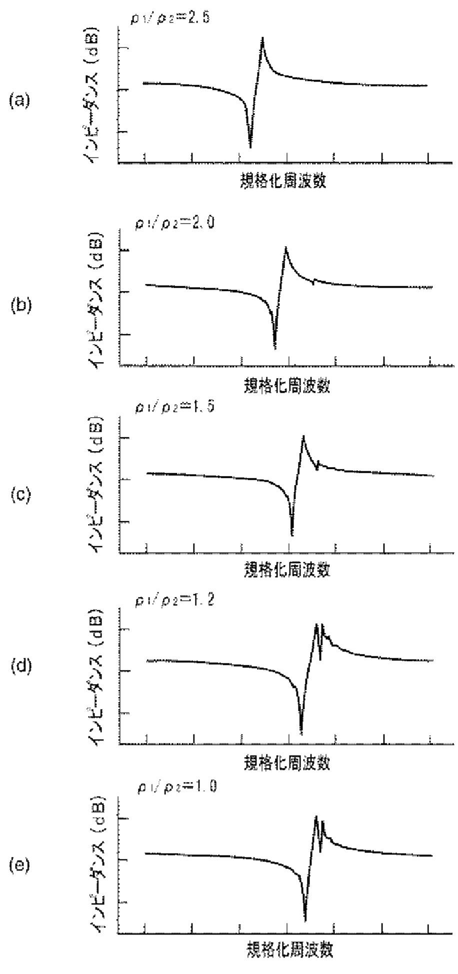
[Drawing 10]



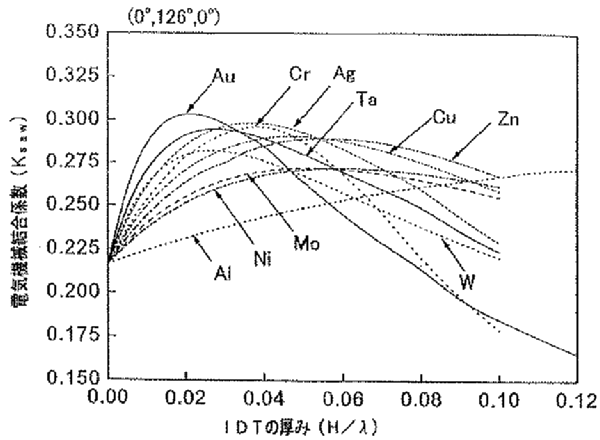
[Drawing 11]



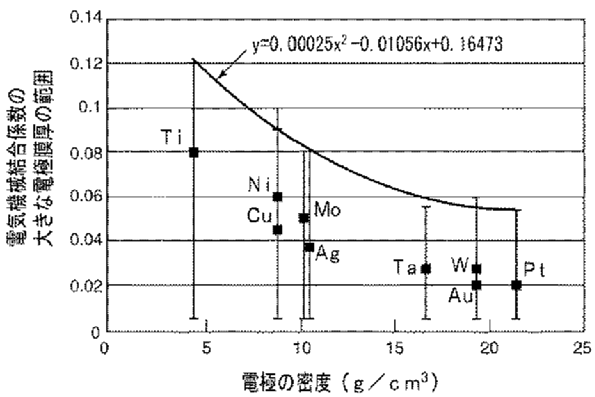
[Drawing 12]



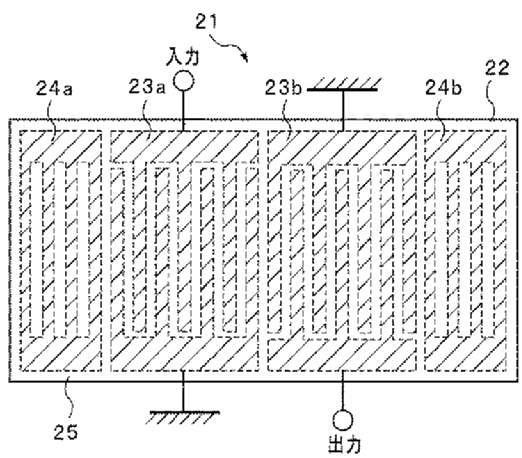
[Drawing 13]



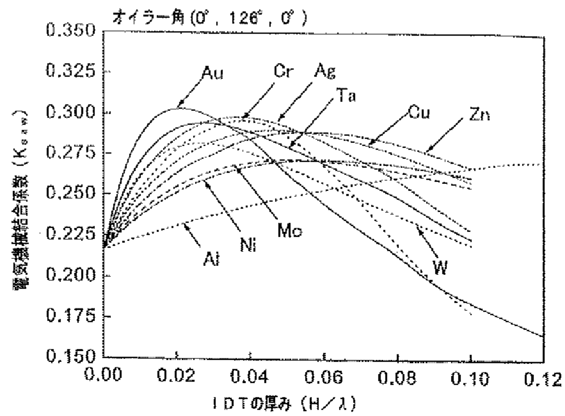
[Drawing 14]



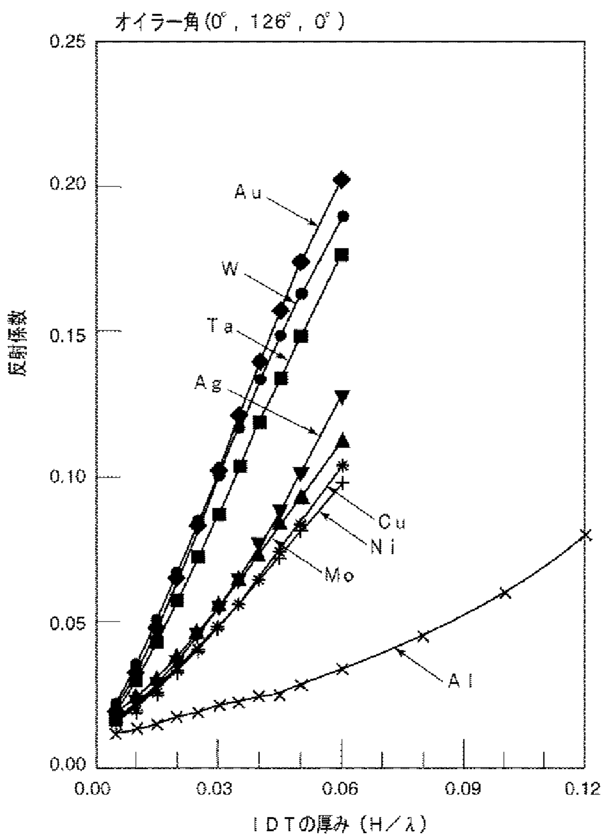
[Drawing 15]



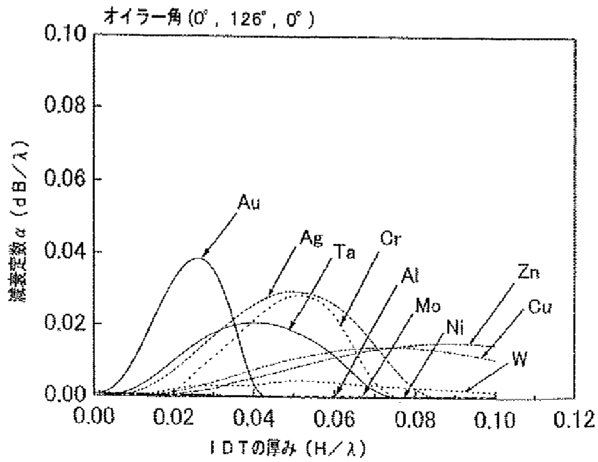
[Drawing 16]



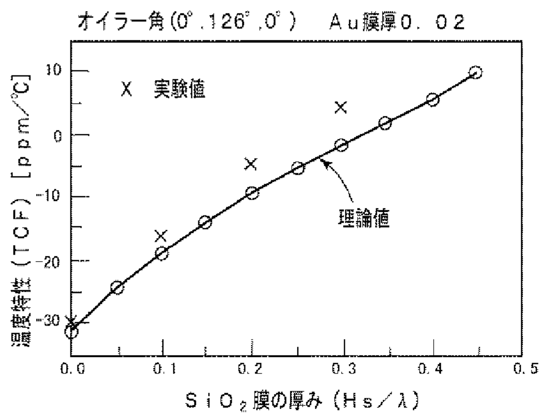
[Drawing 17]



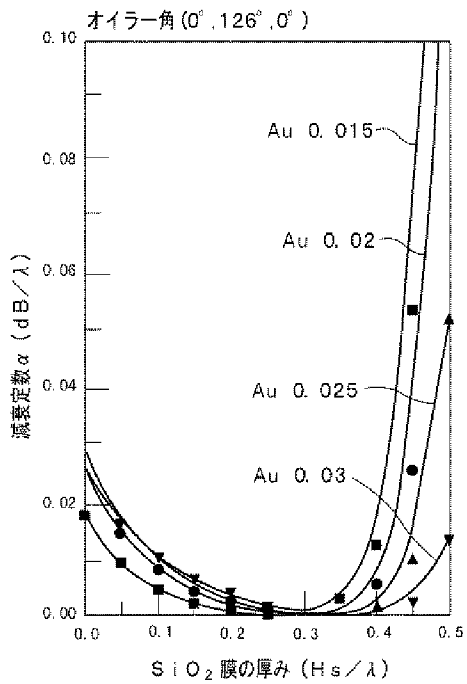
[Drawing 18]



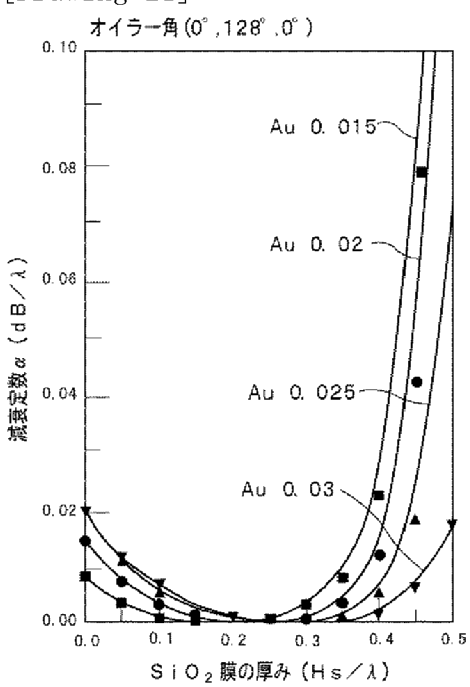
[Drawing 19]



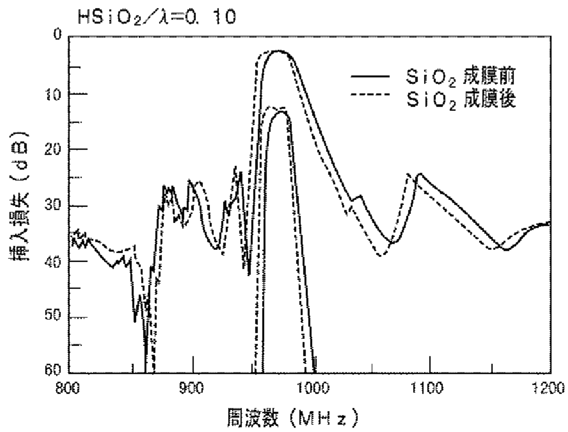
[Drawing 20]



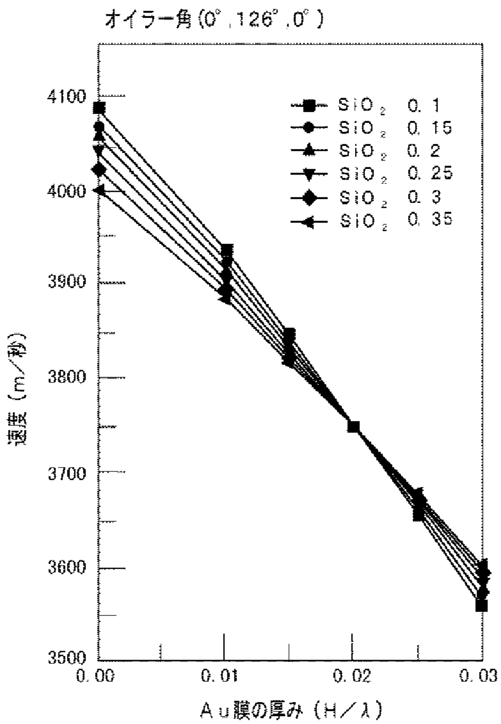
[Drawing 21]



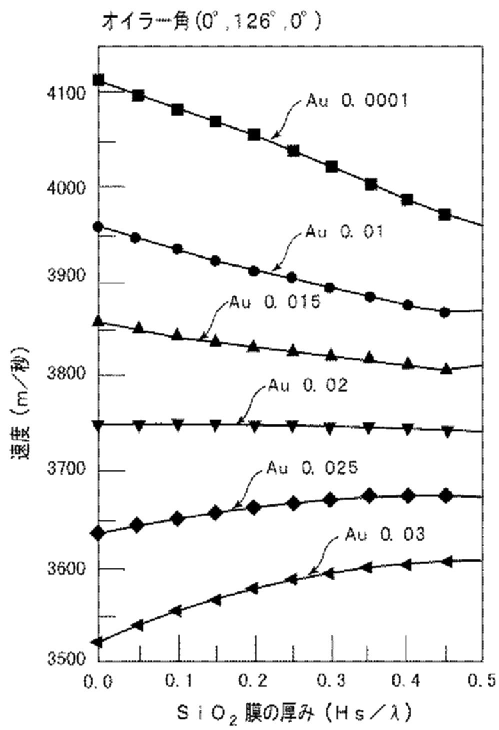
[Drawing 22]



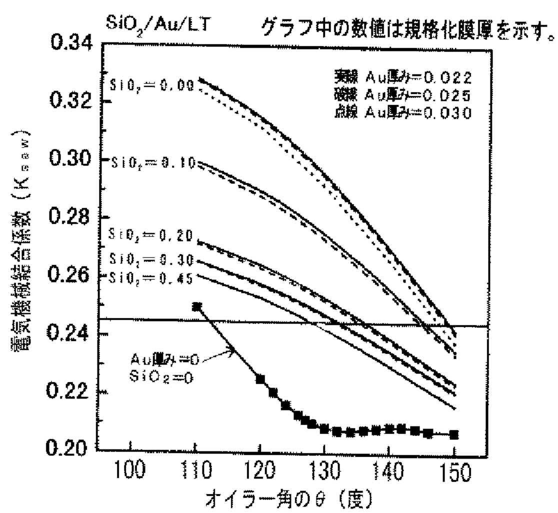
[Drawing 23]



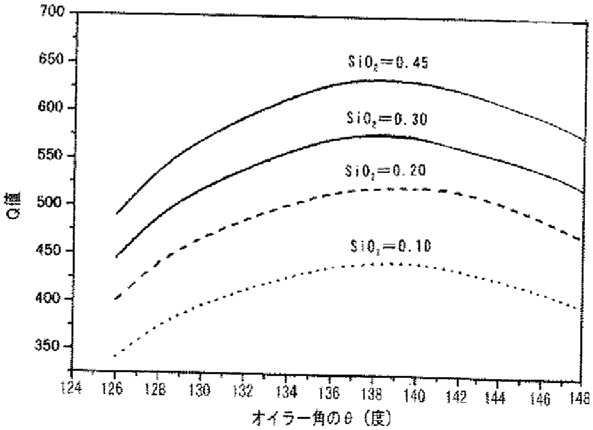
[Drawing 24]



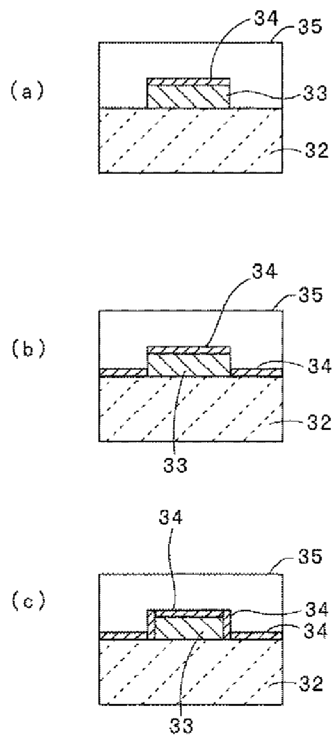
[Drawing 25]



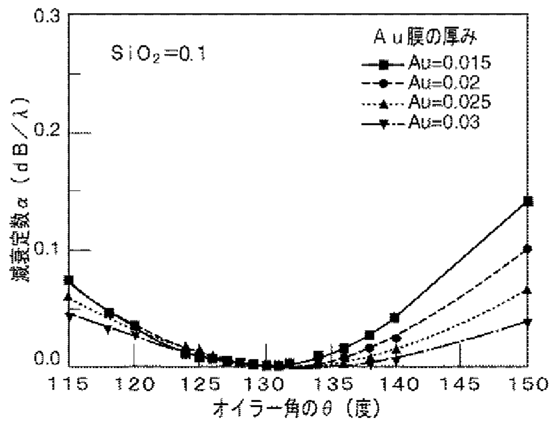
[Drawing 26]



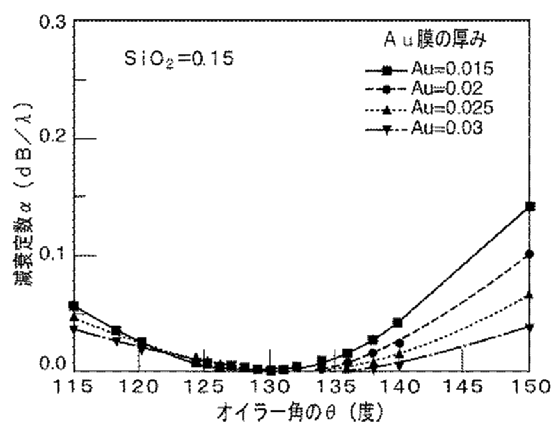
[Drawing 27]



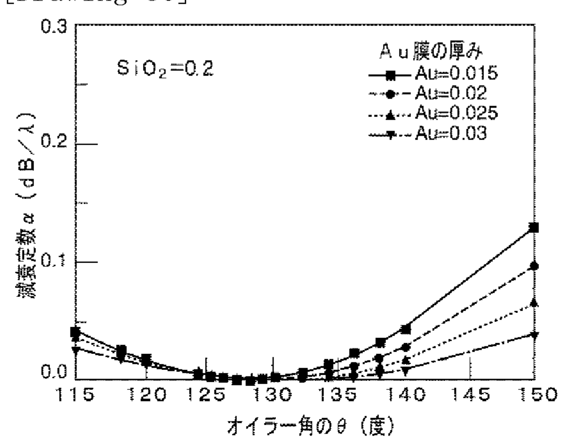
[Drawing 28]



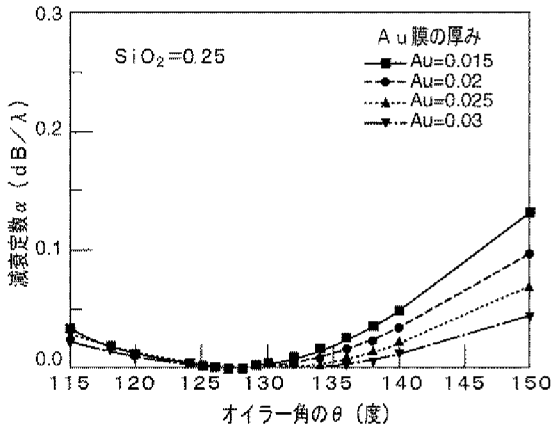
[Drawing 29]



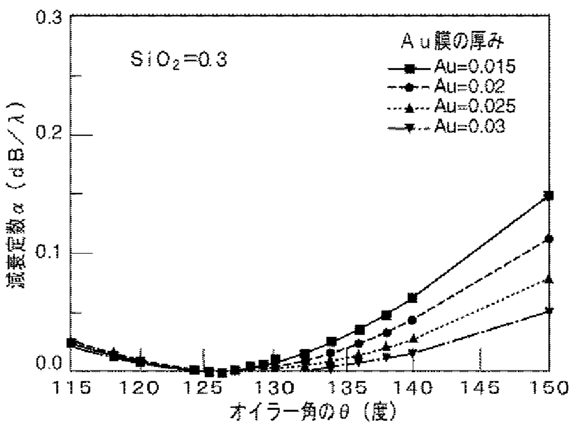
[Drawing 30]



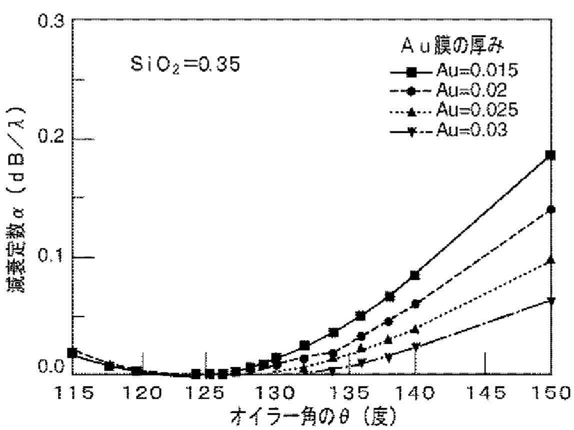
[Drawing 31]



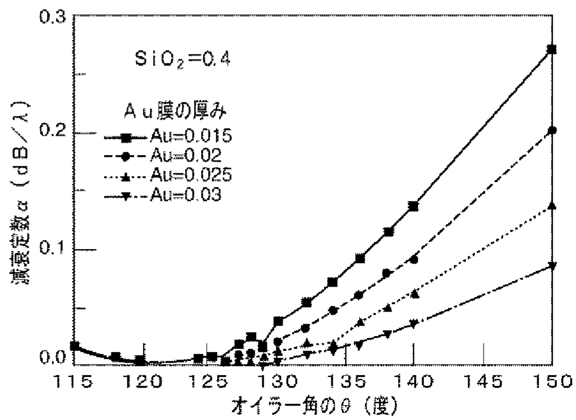
[Drawing 32]



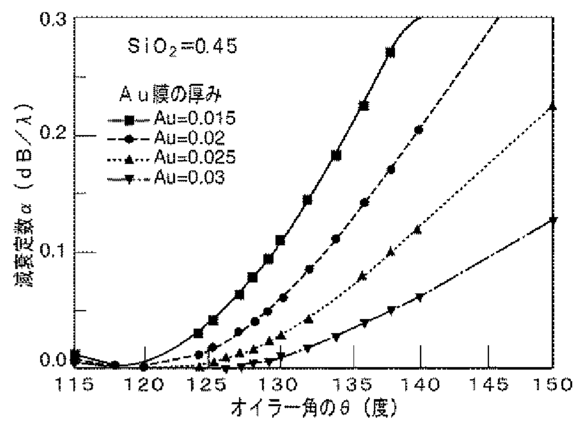
[Drawing 33]



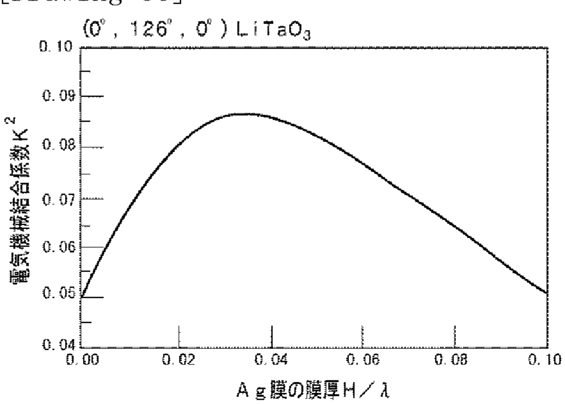
[Drawing 34]



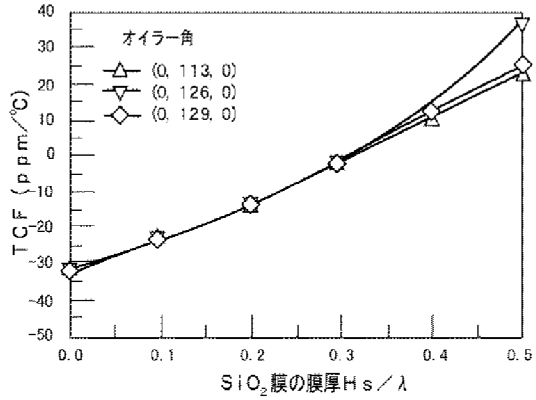
[Drawing 35]



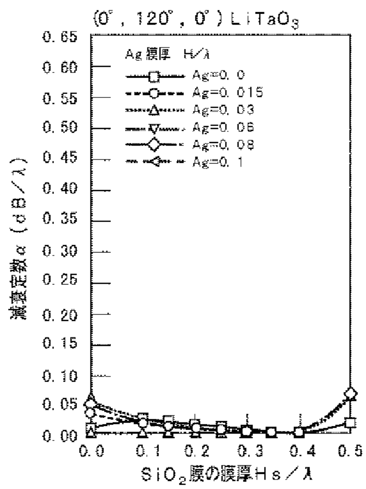
[Drawing 36]



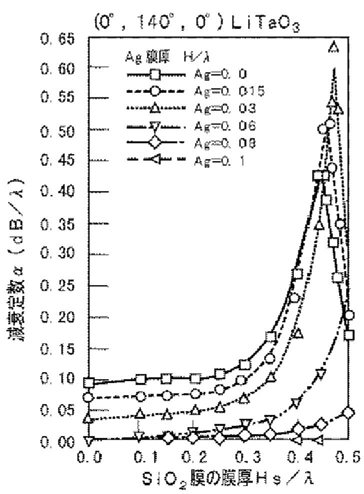
[Drawing 37]



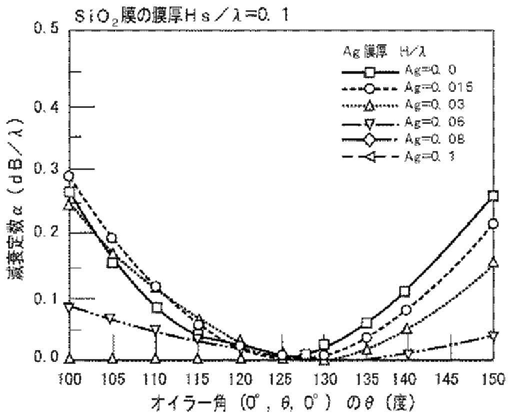
[Drawing 38]



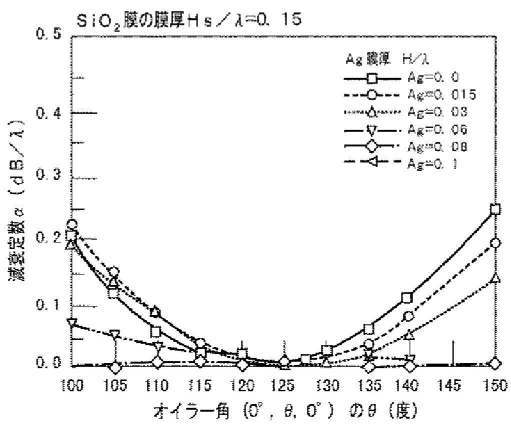
[Drawing 39]



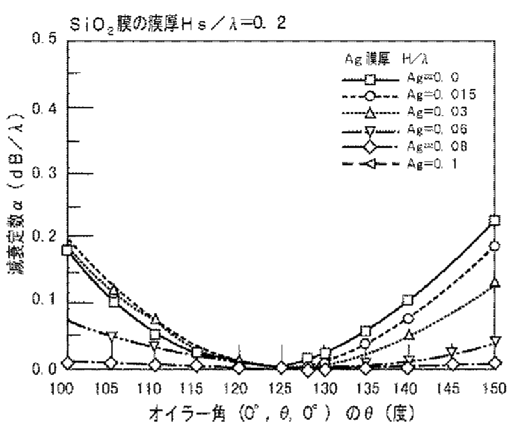
[Drawing 40]



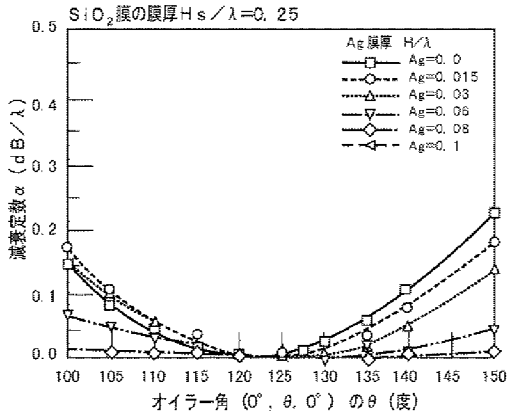
[Drawing 41]



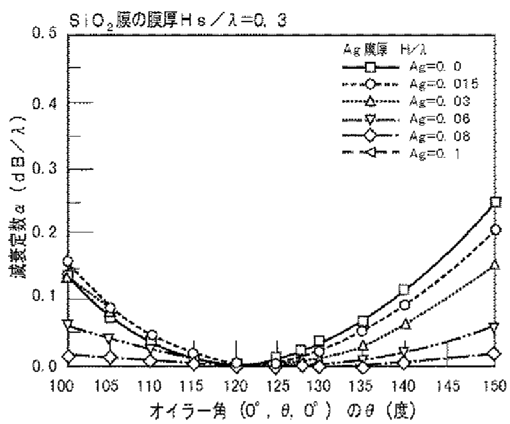
[Drawing 42]



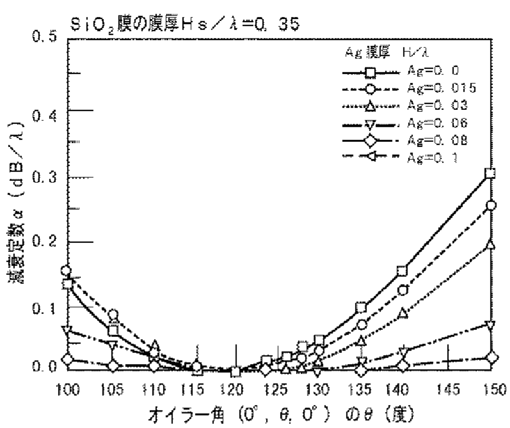
[Drawing 43]



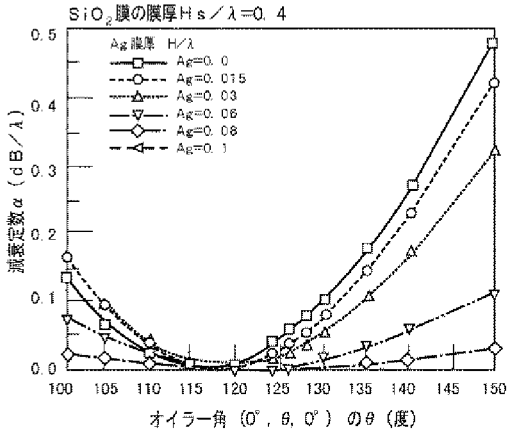
[Drawing 44]



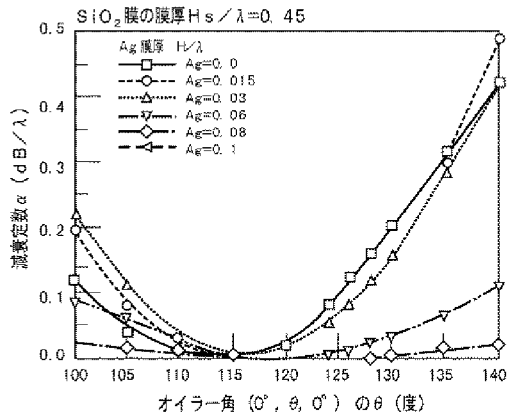
[Drawing 45]



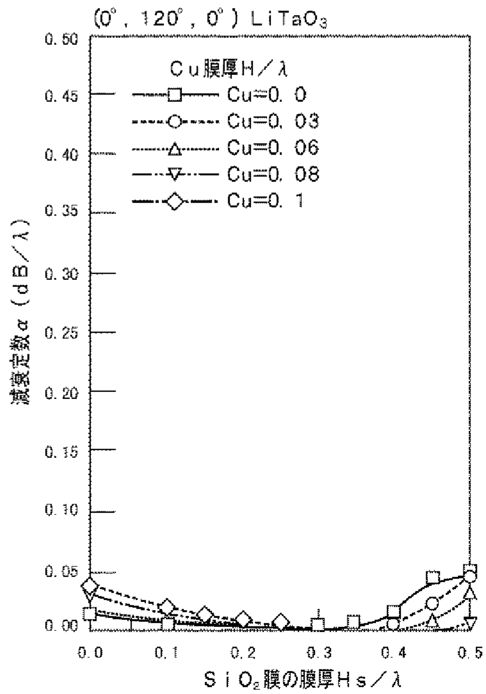
[Drawing 46]



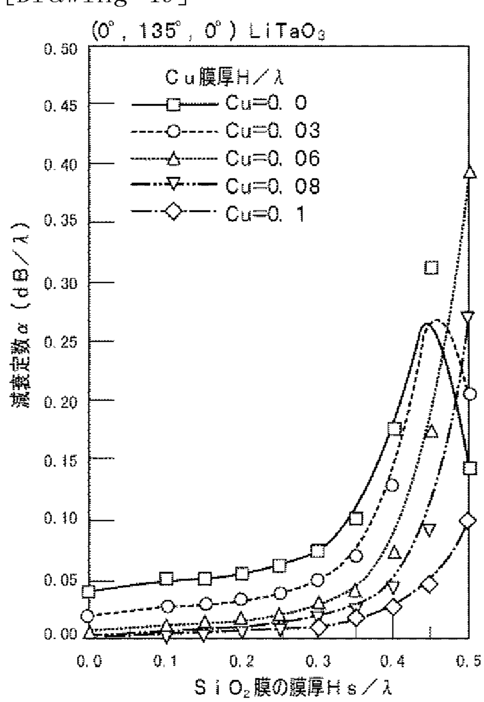
[Drawing 47]



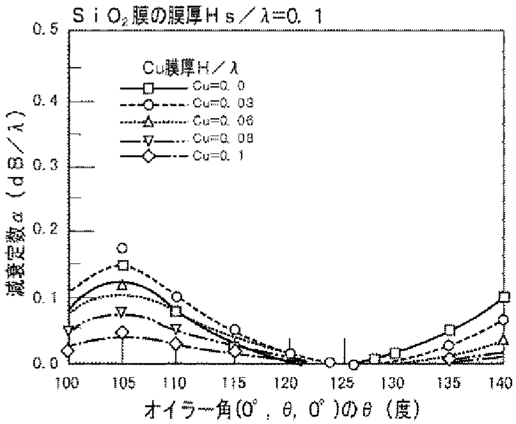
[Drawing 48]



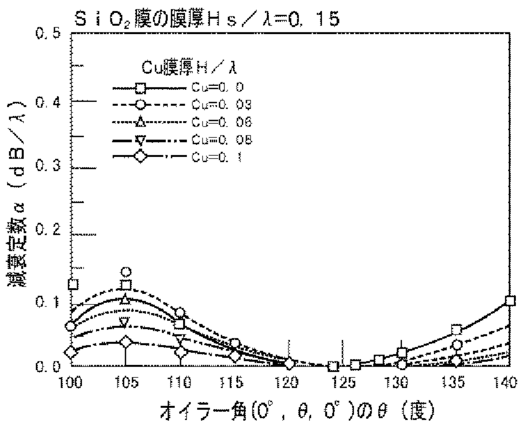
[Drawing 49]



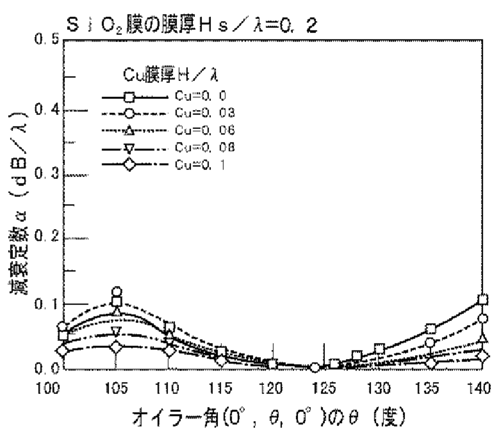
[Drawing 50]



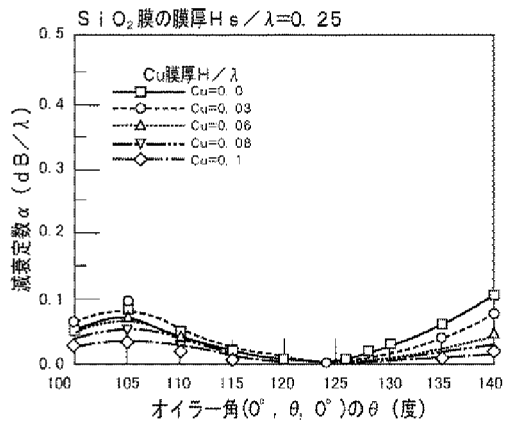
[Drawing 51]



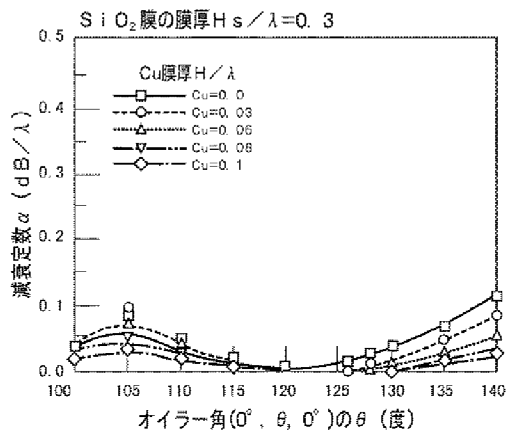
[Drawing 52]



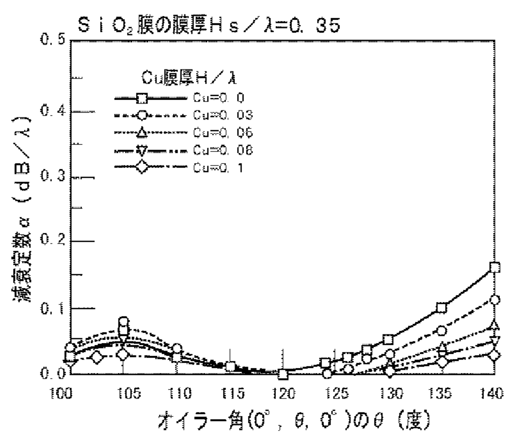
[Drawing 53]



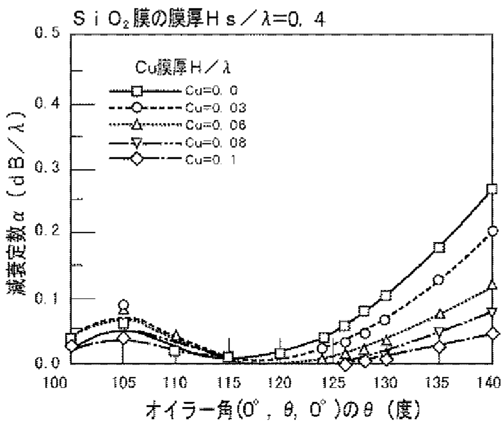
[Drawing 54]



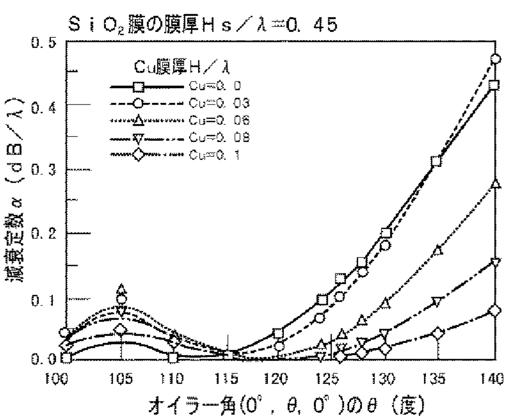
[Drawing 55]



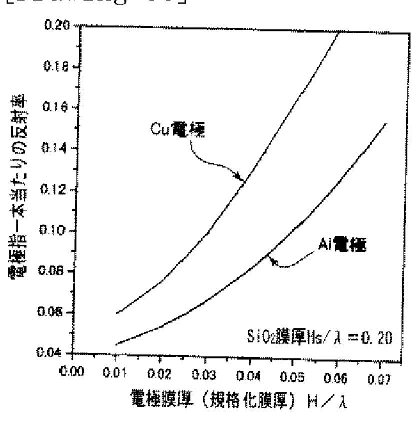
[Drawing 56]



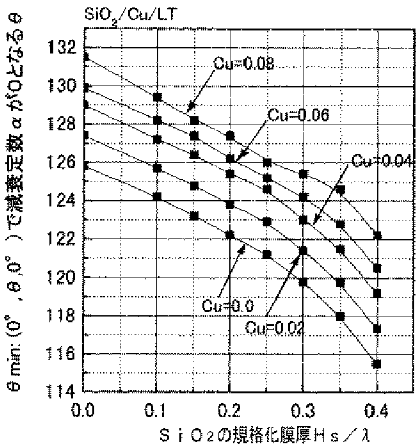
[Drawing 57]



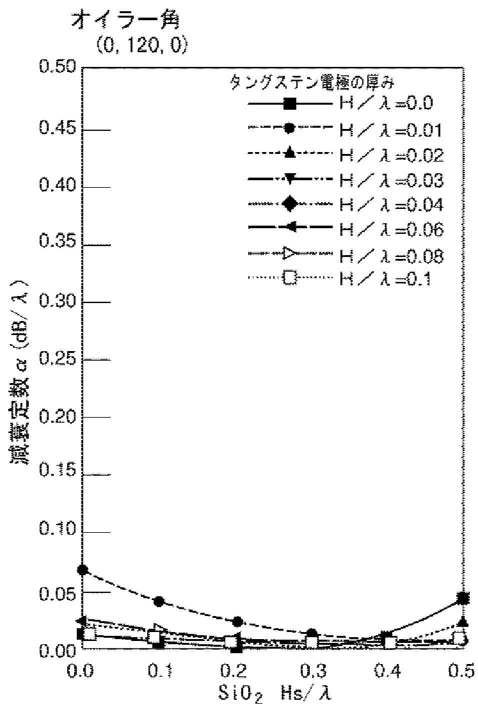
[Drawing 58]



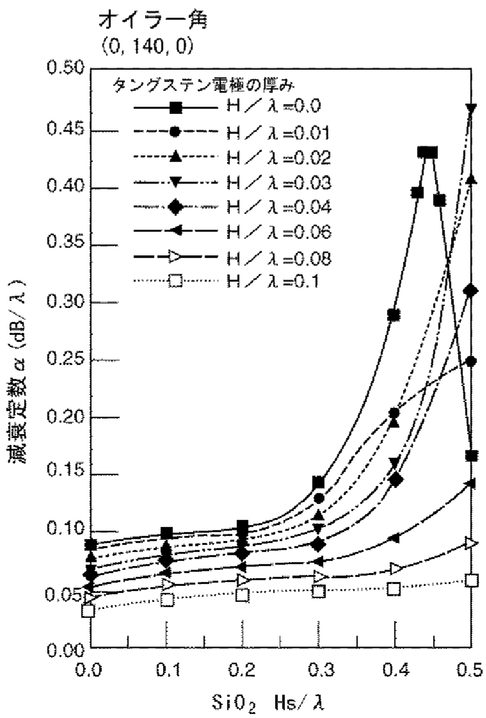
[Drawing 59]



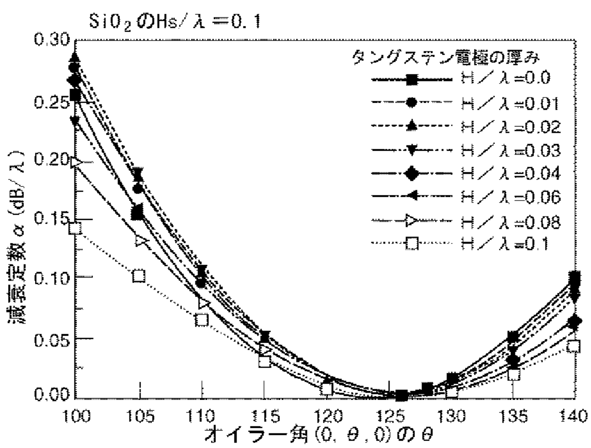
[Drawing 60]



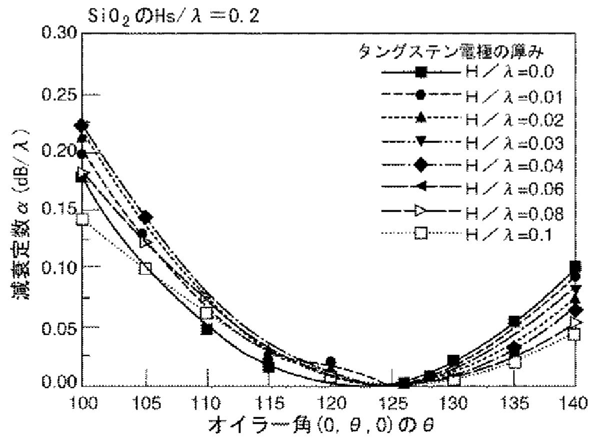
[Drawing 61]



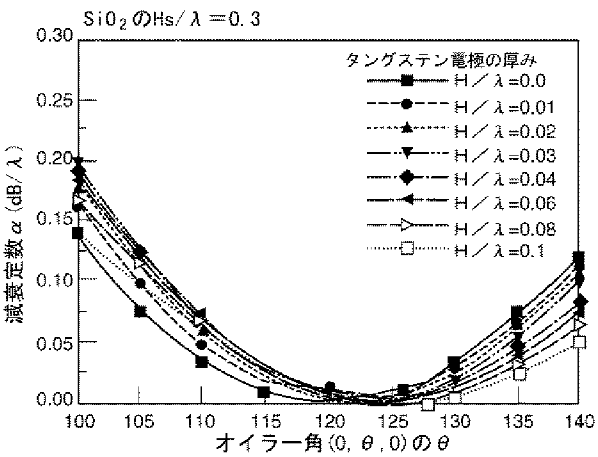
[Drawing 62]



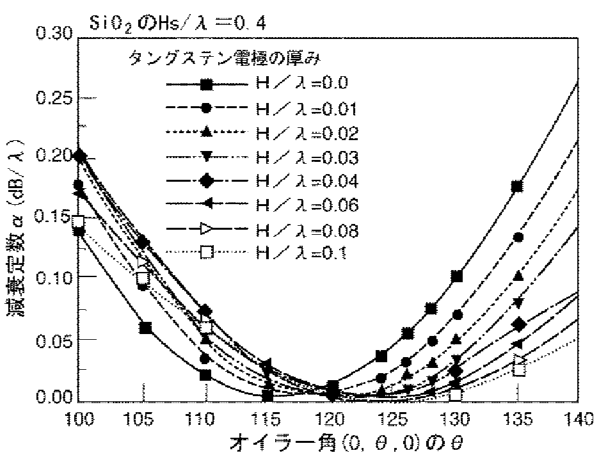
[Drawing 63]



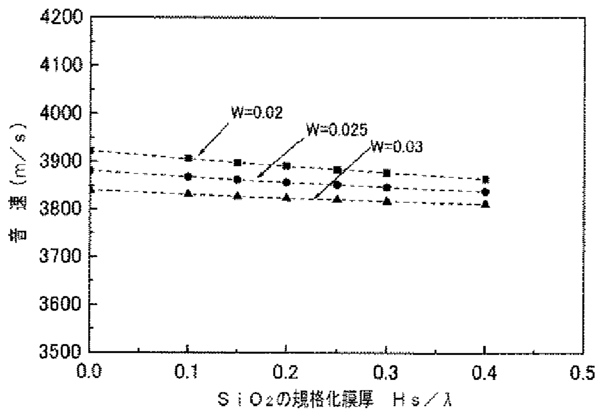
[Drawing 64]



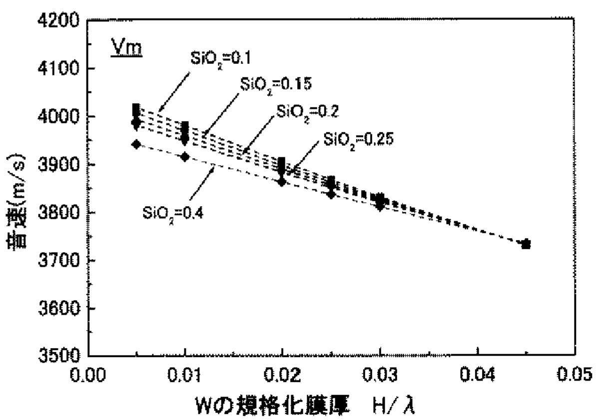
[Drawing 65]



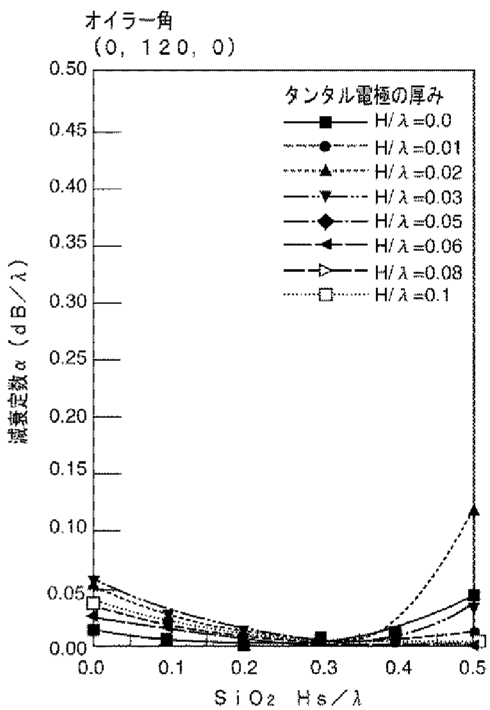
[Drawing 66]



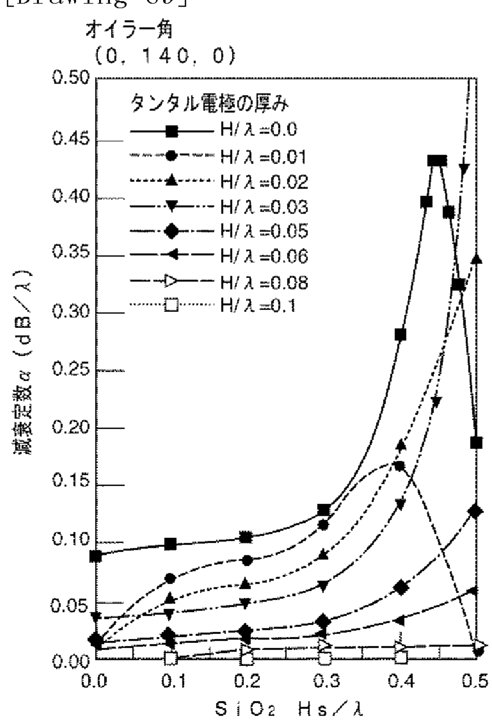
[Drawing 67]



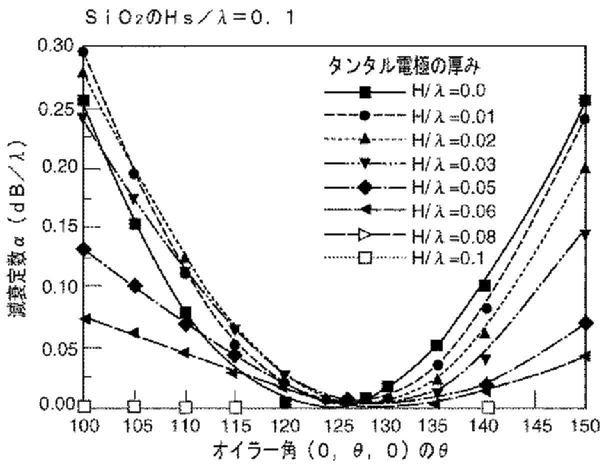
[Drawing 68]



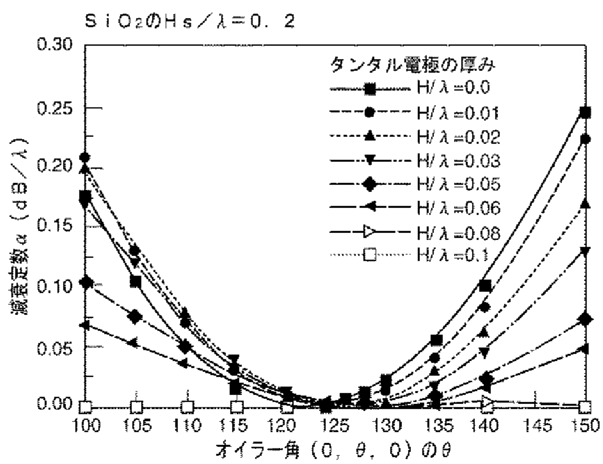
[Drawing 69]



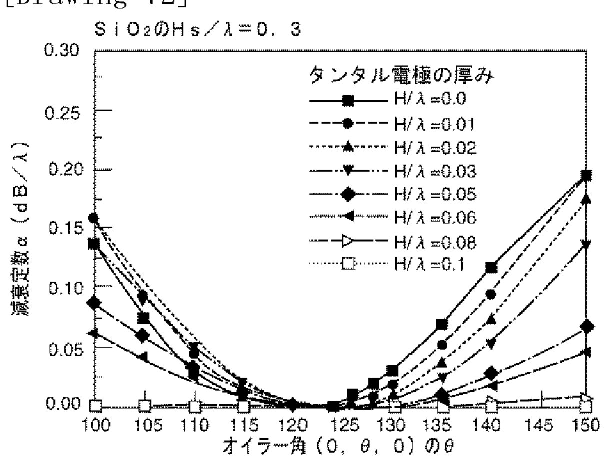
[Drawing 70]



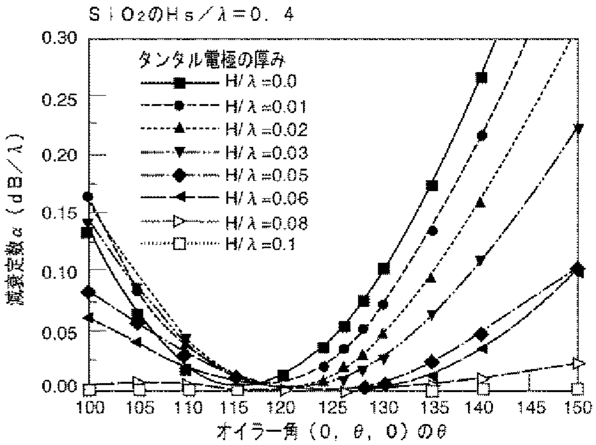
[Drawing 71]



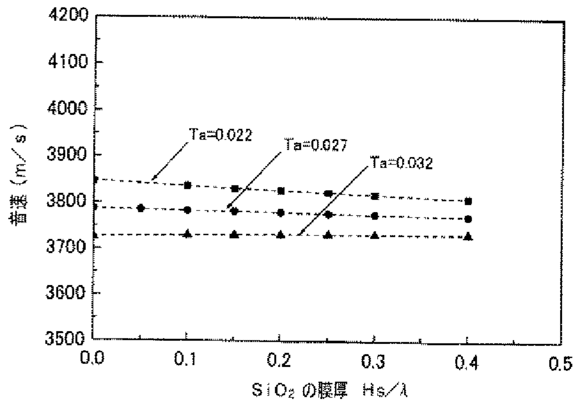
[Drawing 72]



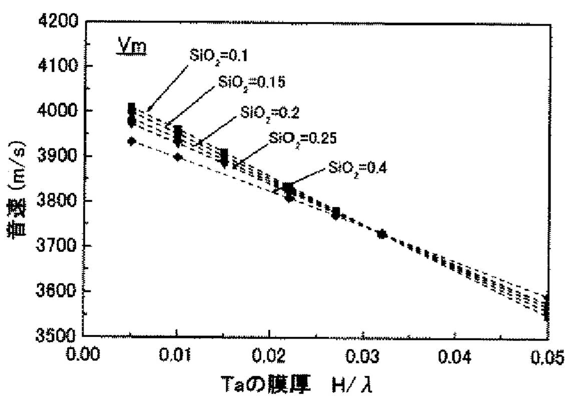
[Drawing 73]



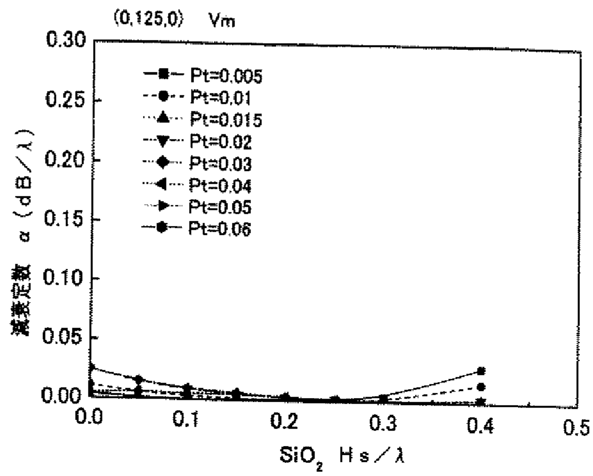
[Drawing 74]



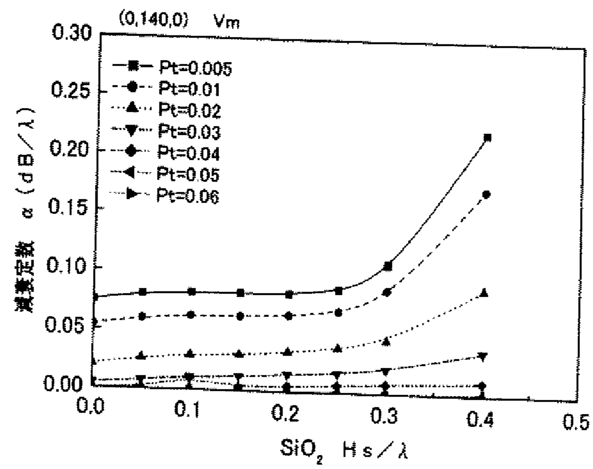
[Drawing 75]



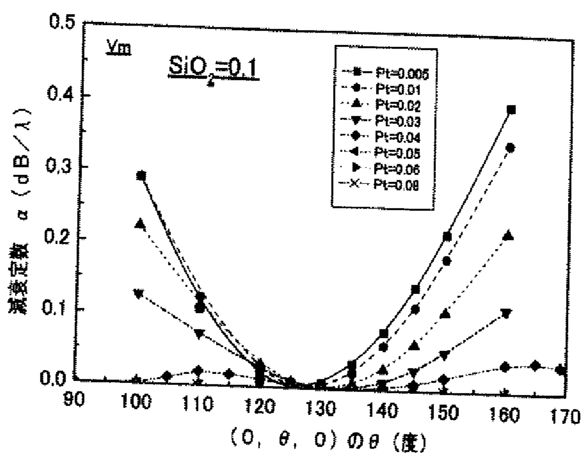
[Drawing 76]



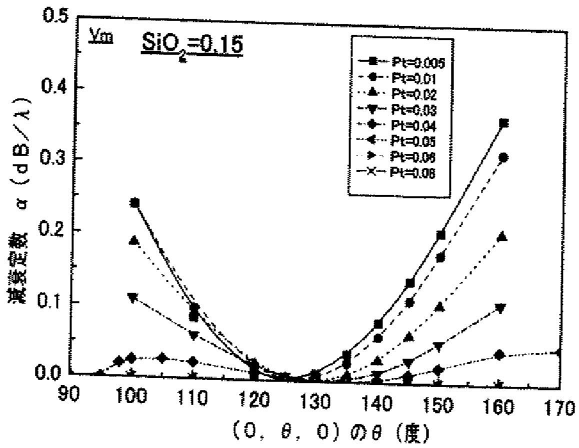
[Drawing 77]



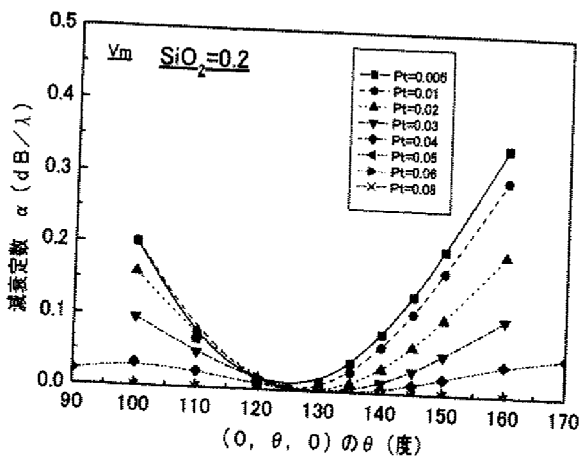
[Drawing 78]



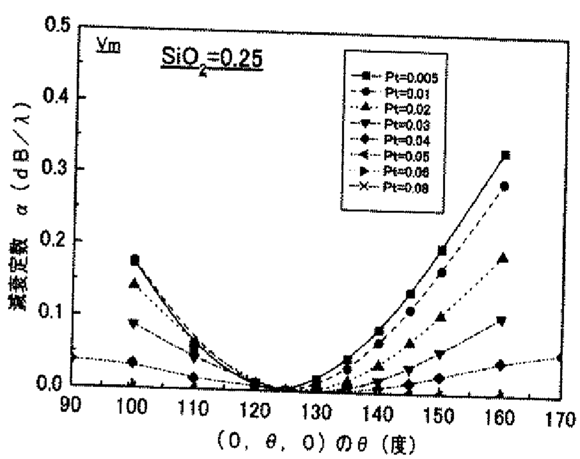
[Drawing 79]



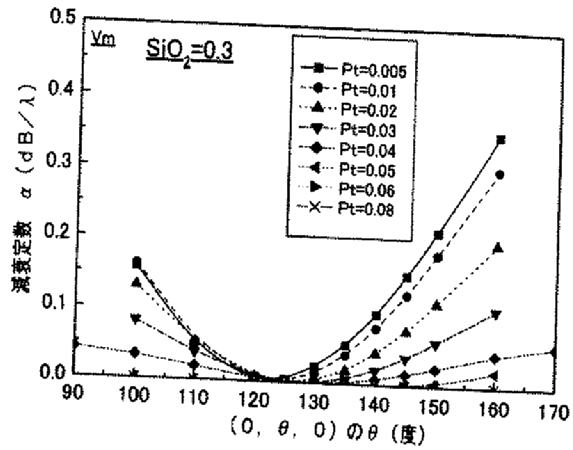
[Drawing 80]



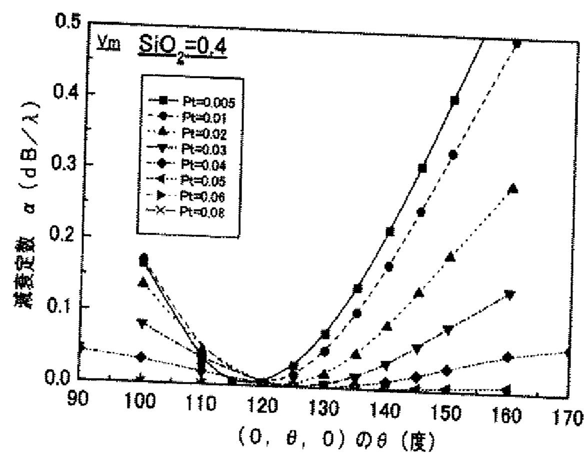
[Drawing 81]



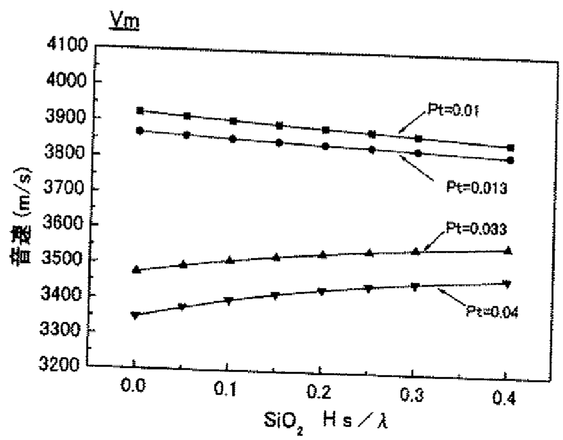
[Drawing 82]



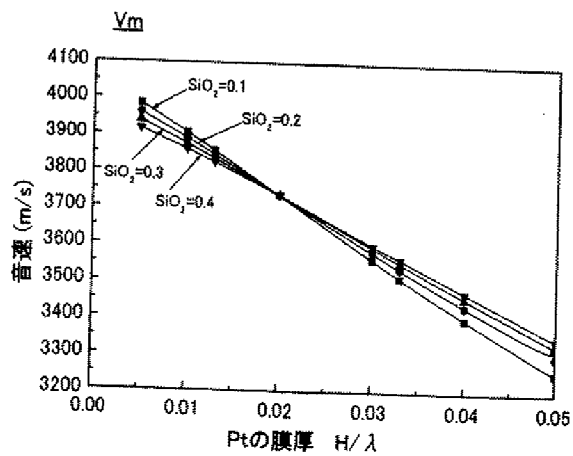
[Drawing 83]



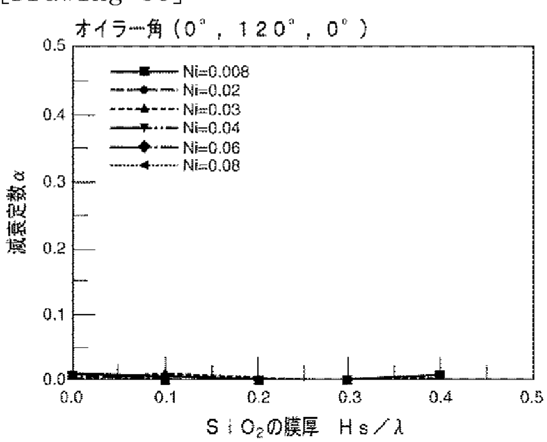
[Drawing 84]



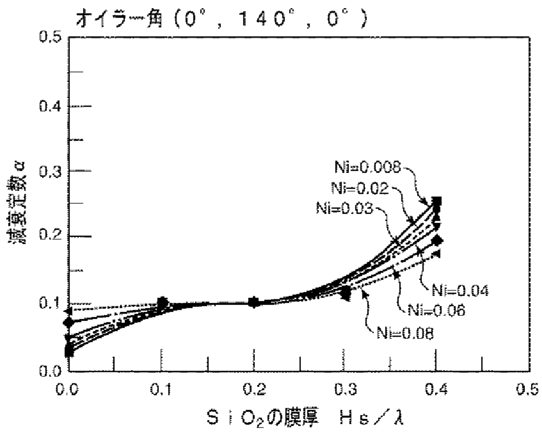
[Drawing 85]



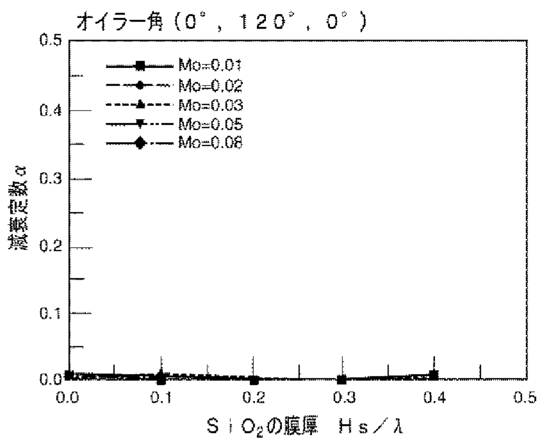
[Drawing 86]



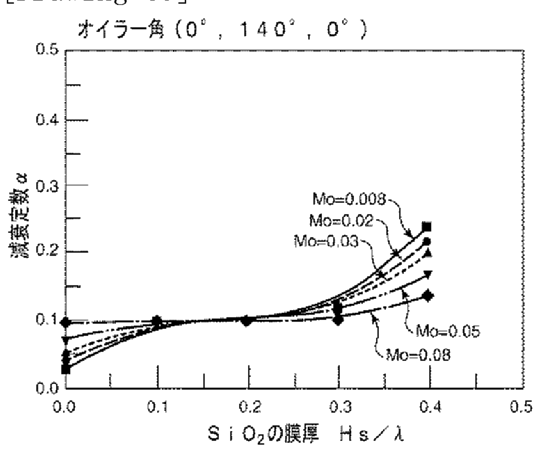
[Drawing 87]



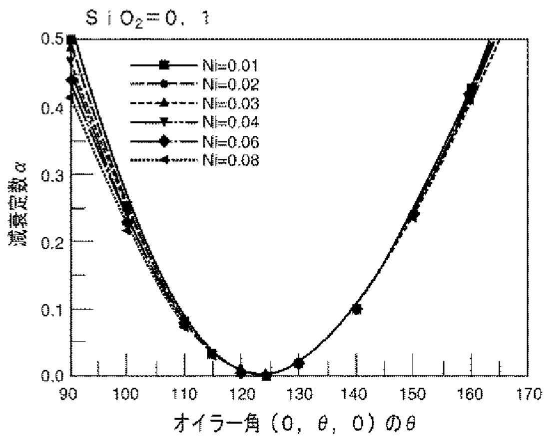
[Drawing 88]



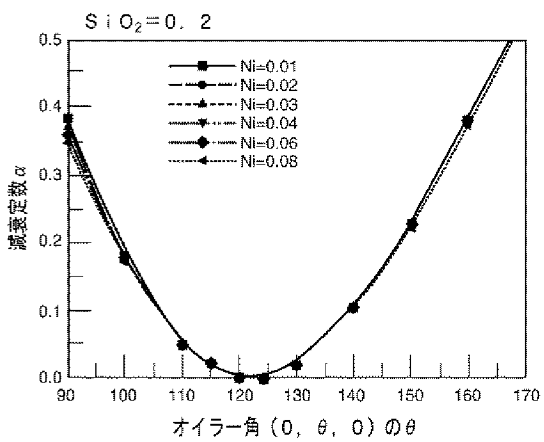
[Drawing 89]



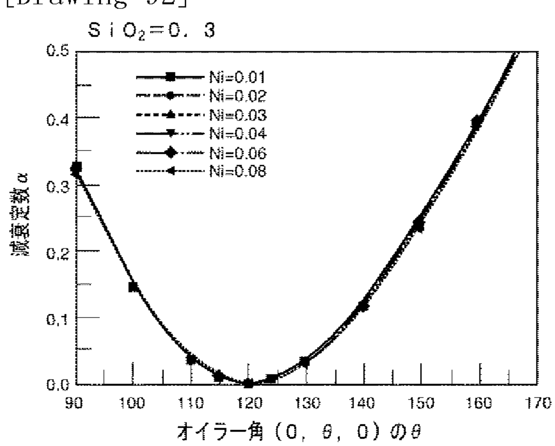
[Drawing 90]



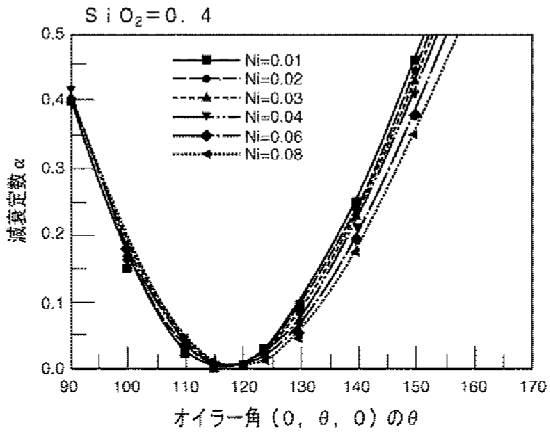
[Drawing 91]



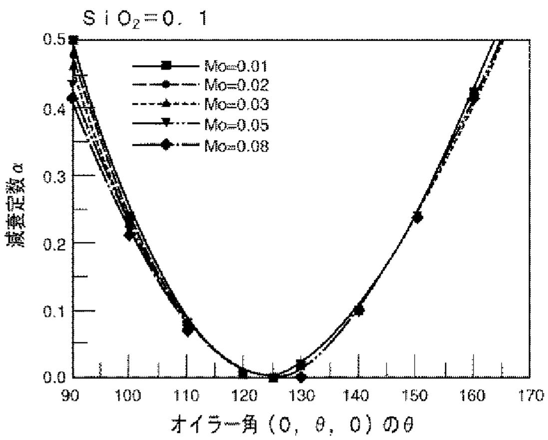
[Drawing 92]



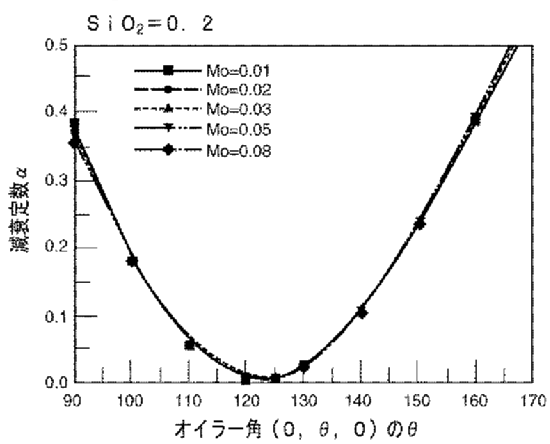
[Drawing 93]



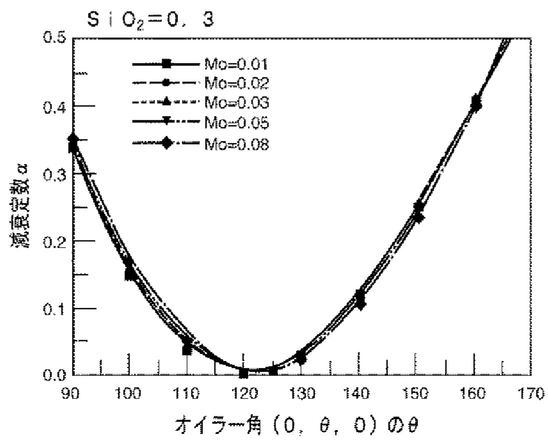
[Drawing 94]



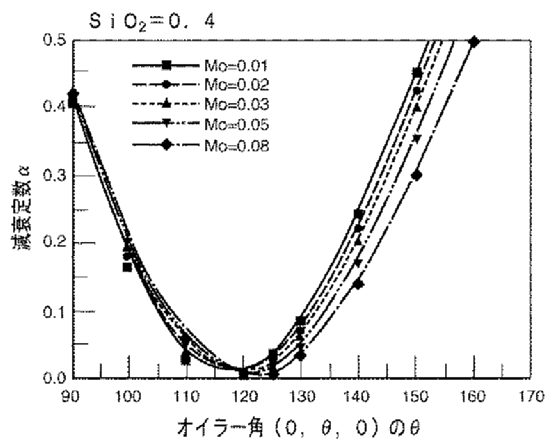
[Drawing 95]



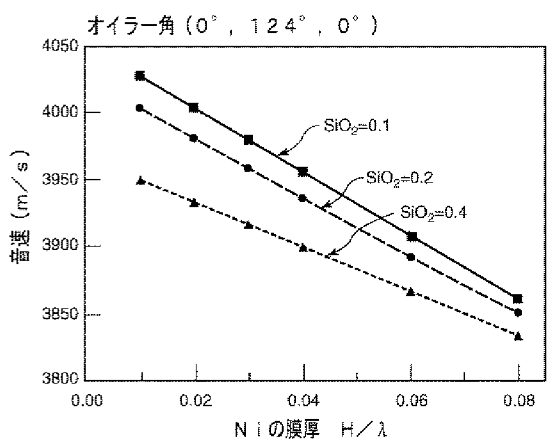
[Drawing 96]



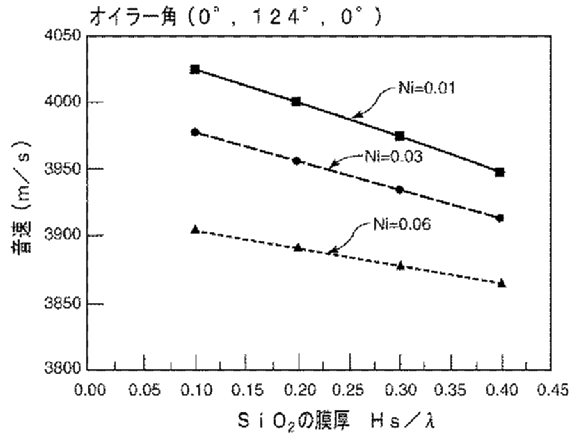
[Drawing 97]



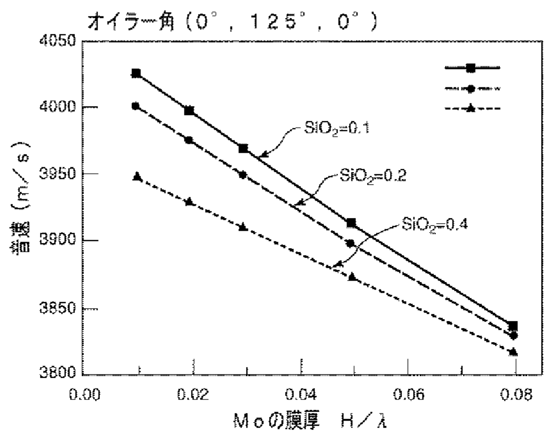
[Drawing 98]



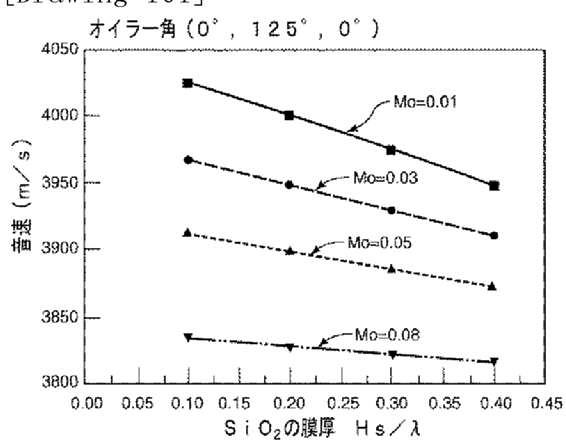
[Drawing 99]



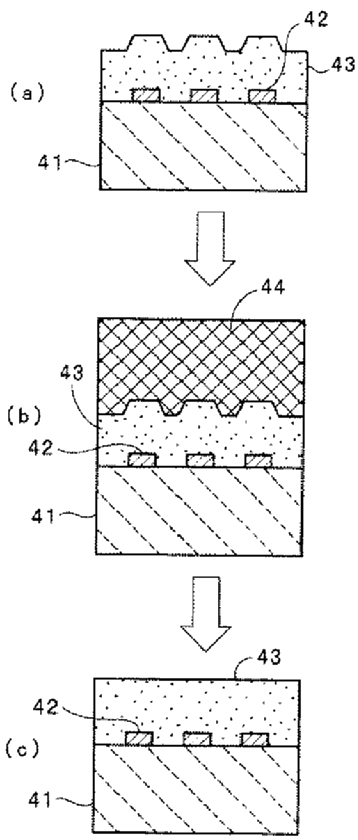
[Drawing 100]



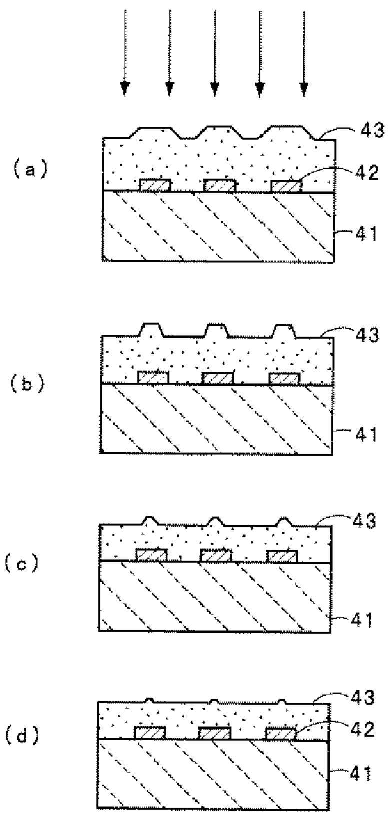
[Drawing 101]



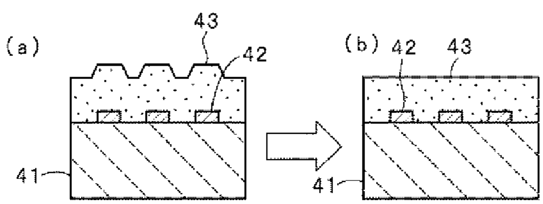
[Drawing 102]



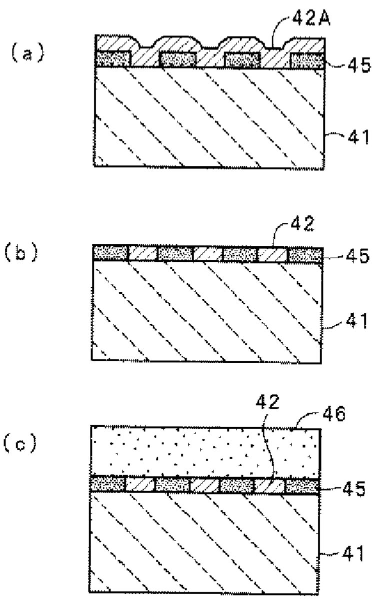
[Drawing 103]



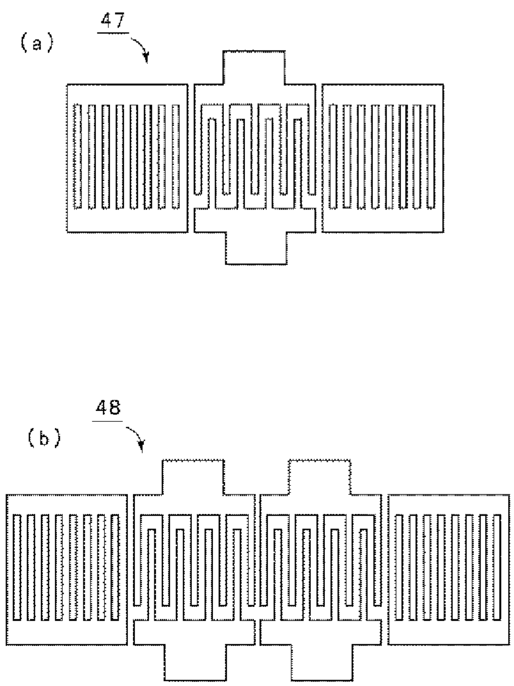
[Drawing 104]



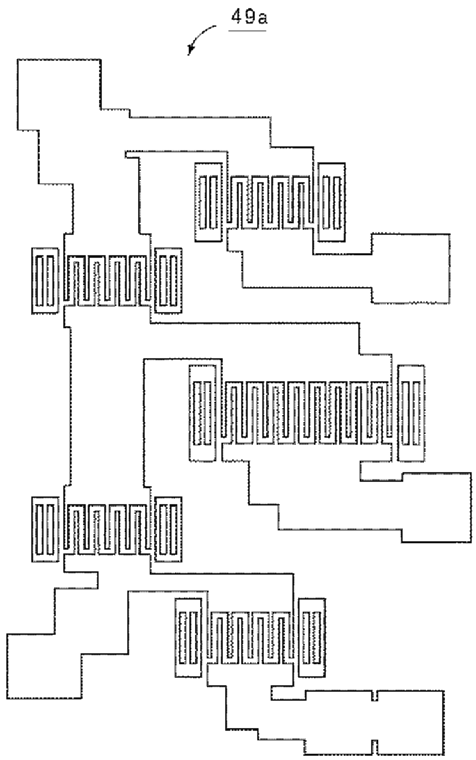
[Drawing 105]



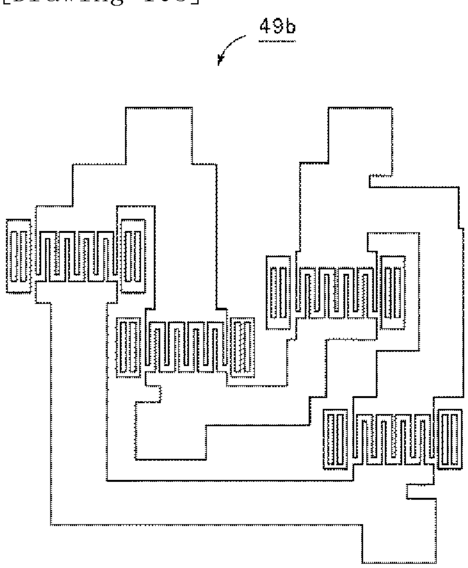
[Drawing 106]



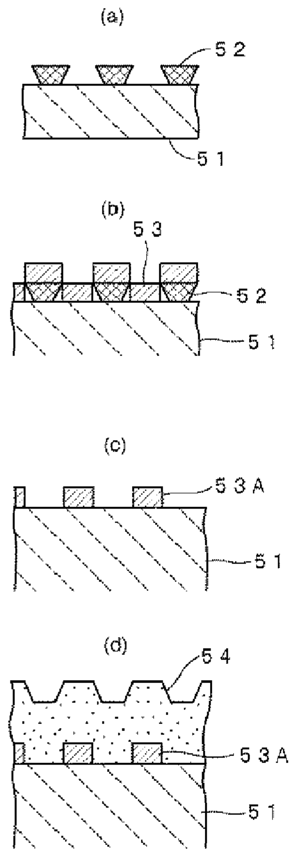
[Drawing 107]



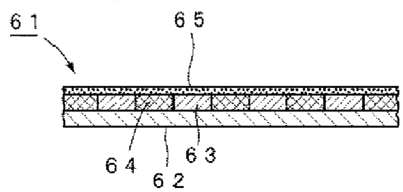
[Drawing 108]



[Drawing 109]



[Drawing 110]



[Translation done.]

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-112748
(P2004-112748A)
(43)公開日　平成16年4月8日(2004.4.8)

(51)Int.Cl.[7]	FI			テーマコード（参考）
H03H 9/145	H03H	9/145	C	5J097
H03H 3/08	H03H	3/08		
H03H 9/25	H03H	9/25	C	

審査請求 未請求　請求項の数 61　OL　（全 69 頁）

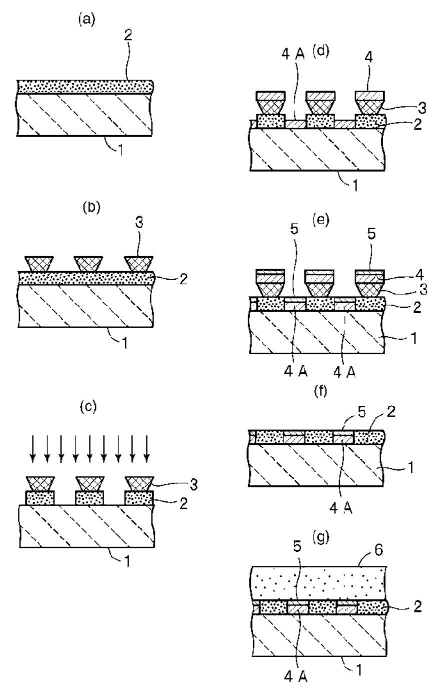
(21)出願番号　特願2003-41480(P2003-41480)
(22)出願日　平成15年2月19日(2003.2.19)
(31)優先権主張番号　特願2002-215614(P2002-215614)
(32)優先日　平成14年7月24日(2002.7.24)
(33)優先権主張国　日本国(JP)

(71)出願人　000006231
株式会社村田製作所
京都府長岡京市天神二丁目２６番１０号
(74)代理人　100086597
弁理士　宮▼崎▲　主税
(72)発明者　門田　道雄
京都府長岡京市天神二丁目２６番１０号
株式会社村田製作所内
(72)発明者　中尾　武志
京都府長岡京市天神二丁目２６番１０号
株式会社村田製作所内
(72)発明者　西山　健次
京都府長岡京市天神二丁目２６番１０号
株式会社村田製作所内

最終頁に続く

(54)【発明の名称】弾性表面波装置及びその製造方法

(57)【要約】
【課題】ＩＤＴ電極を覆うように絶縁物層が形成されている構造を備えた弾性表面波装置であって、ＩＤＴの反射係数が十分に大きく、所望でないリップルによる特性の劣化を抑制し得る弾性表面波装置の製造方法を提供する。
【解決手段】圧電性基板としての$LiTaO_3$基板上に、第１絶縁物層２を全面に形成し、ＩＤＴ電極を形成するためのレジストパターン３を用いて、ＩＤＴ電極が形成される部分の絶縁物層を除去し、第１絶縁物層が除去されている領域にＡｌよりも大きい密度の金属または該金属を主成分とする合金からなる電極膜を形成してＩＤＴ電極４Ａを形成し、第１絶縁物層上に残留しているレジストを除去し、第１絶縁物層２及びＩＤＴ電極４Ａを被覆するように第２絶縁物層６を形成する、弾性表面波装置の製造方法。
【選択図】　図１



【特許請求の範囲】

【請求項１】

電気機械結合係数が１５％以上の$LiTaO_3$または$LiNbO_3$からなる圧電性基板と、
前記圧電性基板上に形成されており、Ａｌよりも密度の大きい金属もしくは該金属を主成分とする合金、またはＡｌよりも密度の大きい金属もしくは該金属を主成分とする合金と他の金属とからなる積層膜からなる少なくとも１つの電極と、
前記少なくとも１つの電極が形成されている領域を除いた残りの領域において、前記電極と略等しい膜厚に形成された第１絶縁物層と、
前記電極及び第１絶縁物層を被覆するように形成された第２絶縁物層とを備え、
前記電極の密度が、前記第１絶縁物層の１．５倍以上である、弾性表面波装置。

【請求項２】

圧電性基板と、
前記圧電性基板上に形成された少なくとも１つの電極と、
前記電極上に形成されており、かつ電極を構成する金属もしくは合金よりも耐腐食性に優れた金属もしくは合金からなる保護金属膜と、
前記少なくとも１つの電極が形成されている領域を除いた残りの領域において、前記電極と保護金属膜との合計の膜厚と略等しい膜厚を有するように形成された第１絶縁物層と、
前記保護金属膜及び第１絶縁物層を被覆するように形成された第２絶縁物層とを備える、弾性表面波装置。

【請求項３】

前記電極及び保護金属膜の積層構造の全体の平均密度が、前記第１絶縁物層の密度の１．５倍以上である、請求項２に記載の弾性表面波装置。

【請求項４】

前記第１，第２の絶縁物層がSiO_2により形成されている、請求項１～３のいずれかに記載の弾性表面波装置。

【請求項５】

弾性表面波の反射を利用した弾性表面波装置である、請求項１～４のいずれかに記載の弾性表面波装置。

【請求項６】

前記圧電性基板が、オイラー角（０±３°，１０４°～１４０°，０±３°）の$LiTaO_3$基板であり、前記第１，第２の絶縁物層がSiO_2より構成されており、第１，第２絶縁物層を構成しているSiO_2膜の合計膜厚をＨＳ、弾性表面波の波長をλとしたときに、ＨＳ／λが０．０３～０．４５の範囲とされており、前記電極の厚みをＨ、弾性表面波の波長をλとしたときに、電極の規格化膜厚Ｈ／λが、下記の式（１）を満たす値とされている、請求項１～５のいずれかに記載の弾性表面波装置。

$0.005 \leq H/\lambda \leq 0.00025 \times \rho^2 - 0.01056 \times \rho + 0.16473$（但し、ρは電極の平均密度）　　式（１）

【請求項７】

前記圧電性基板が、オイラー角（０±３°，１１５°～１４８°，０±３°）の$LiTaO_3$基板であり、前記第１，第２の絶縁物層がSiO_2膜からなり、SiO_2膜の合計の規格化膜厚ＨＳ／λが０．０３～０．４５の範囲にあり、
前記Ａｌよりも密度の大きい金属が密度１５０００～２３０００kg/m^3及びヤング率0.5×10^{11}～1.0×10^{11} N/m^2あるいは横波音速が１０００～２０００ｍ／ｓである金属であり、前記電極の膜厚をＨ、弾性表面波の波長をλとしたときに、規格化膜厚Ｈ／λが０．０１３～０．０３２の範囲にある、請求項１，４～６のいずれかに記載の弾性表面波装置。

【請求項８】

前記金属がＡｕである、請求項７に記載の弾性表面波装置。

【請求項９】

前記ＬｉＴａＯ$_3$基板のオイラー角が（０±３°，１３２°～１４８°，０±３°）の範囲にある、請求項７または８に記載の弾性表面波装置。
【請求項１０】
前記ＬｉＴａＯ$_3$基板のオイラー角のθが１１５°以上、１３２°未満の範囲にある、請求項７または８に記載の弾性表面波装置。
【請求項１１】
前記ＬｉＴａＯ$_3$基板のオイラー角（０±３°，θ，０±３°）、前記電極の規格化膜厚Ｈ／λ及び第１，第２絶縁物層を構成しているＳｉＯ$_2$の規格化膜厚ＨＳ／λが、下記の表１で示されている組み合わせのいずれかである、請求項７または８に記載の弾性表面波装置。
【表１】

オイラー角 (0±3°，θ，0±3°) のθ	Ａu膜厚	ＳｉＯ$_2$膜厚
120.0°≦θ＜123.0°	0.013～0.018	0.15～0.45
123.0°≦θ＜124.5°	0.013～0.022	0.10～0.40
124.5°≦θ＜125.5°	0.013～0.025	0.07～0.40
125.5°≦θ＜127.5°	0.013～0.025	0.06～0.40
127.5°≦θ＜129.0°	0.013～0.028	0.04～0.40
129.0°≦θ＜130.0°	0.017～0.030	0.03～0.42
130.0°≦θ＜131.5°	0.017～0.030	0.03～0.42
131.5°≦θ＜133.0°	0.018～0.028	0.05～0.33
133.0°≦θ＜135.0°	0.018～0.030	0.05～0.30
135.0°≦θ≦137.0°	0.019～0.032	0.05～0.25
137.0°≦θ≦140.0°	0.019～0.032	0.05～0.25

【請求項１２】
前記ＬｉＴａＯ$_3$基板のオイラー角（０±３°，θ，０±３°）、前記電極の規格化膜厚Ｈ／λ及び第１，第２絶縁物層を構成しているＳｉＯ$_2$の規格化膜厚ＨＳ／λが、下記の表２に示されている組み合わせのいずれかである、請求項７または８に記載の弾性表面波装置。
【表２】

オイラー角 (0±3°，θ，0±3°) のθ	Ａu膜厚	ＳｉＯ$_2$膜厚
129.0°≦θ＜130.0°	0.022～0.028	0.04～0.40
130.0°≦θ＜131.5°	0.022～0.028	0.04～0.40
131.5°≦θ＜133.0°	0.022～0.028	0.05～0.33
133.0°≦θ＜135.0°	0.022～0.030	0.05～0.30
135.0°≦θ＜137.0°	0.022～0.032	0.05～0.25
137.0°≦θ≦140.0°	0.022～0.032	0.05～0.25

【請求項１３】
前記圧電性基板が、オイラー角（０±３°，１１３°～１４２°，０±３°）のＬｉＴａＯ$_3$基板であり、前記第１，第２絶縁物層がＳｉＯ$_2$膜からなり、ＳｉＯ$_2$膜の合計の規

格化膜厚ＨＳ／λが０．１０～０．４０の範囲にあり、
前記Ａｌよりも密度の大きい金属が密度５０００～１５０００ｋｇ／ｍ^{3}及びヤング率０．５×１０^{11}～１．０×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が１０００～２０００ｍ／ｓである金属であり、前記電極の膜厚をＨ、弾性表面波の波長をλとしたときに、規格化膜厚Ｈ／λが０．０１～０．０８の範囲にある、請求項１，４～６のいずれかに記載の弾性表面波装置。

【請求項１４】
前記金属がＡｇである、請求項１３に記載の弾性表面波装置。

【請求項１５】
前記電極の規格化膜厚Ｈ／λが０．０１～０．０８であり、前記ＳｉＯ$_2$膜の合計の規格化膜厚ＨＳ／λと、ＬｉＴａＯ$_3$基板のオイラー角が下記の表３に示す組み合わせのいずれかである、請求項１３または１４に記載の弾性表面波装置。

【表３】

Ａｇ膜厚Ｈ／λ：０．０１～０．０８のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角
０．１５～０．１８	０±３，１１７～１３７，０±３
０．１８～０．２３	０±３，１１７～１３６，０±３
０．２３～０．２８	０±３，１１５～１３５，０±３
０．２８～０．３３	０±３，１１３～１３３，０±３
０．３３～０．３８	０±３，１１３～１３５，０±３
０．３８～０．４０	０±３，１１３～１３２，０±３

【請求項１６】
前記電極の規格化膜厚Ｈ／λが０．０２～０．０６であり、前記ＳｉＯ$_2$膜の合計の規格化膜厚ＨＳ／λと、ＬｉＴａＯ$_3$基板のオイラー角が下記の表４に示す組み合わせのいずれかである、請求項１３または１４に記載の弾性表面波装置。

【表４】

Ａｇ膜厚Ｈ／λ：０．０２～０．０６のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角
０．１５～０．１８	０±３，１２０～１３３，０±３
０．１８～０．２３	０±３，１２０～１３７，０±３
０．２３～０．２８	０±３，１２０～１３５，０±３
０．２８～０．３３	０±３，１１８～１３５，０±３
０．３３～０．３８	０±３，１１５～１３３，０±３
０．３８～０．４０	０±３，１１３～１３０，０±３

【請求項１７】
前記電極の規格化膜厚Ｈ／λが０．０３～０．０５であり、前記ＳｉＯ$_2$膜の合計の規格化膜厚ＨＳ／λと、ＬｉＴａＯ$_3$基板のオイラー角が下記の表５に示す組み合わせのいずれかである、請求項１３または１４に記載の弾性表面波装置。

【表５】

Ａｇ膜厚Ｈ／λ：０．０３～０．０５のとき

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角
０．１５～０．１８	０±３，１２２～１４２，０±３
０．１８～０．２３	０±３，１２０～１４０，０±３
０．２３～０．２８	０±３，１１７～１３８，０±３
０．２８～０．３３	０±３，１１６～１３６，０±３
０．３３～０．３８	０±３，１１４～１３５，０±３
０．３８～０．４０	０±３，１１３～１３０，０±３

【請求項１８】
前記圧電性基板が、オイラー角（０±３°，１１３°～１３７°，０±３°）のＬｉＴａＯ$_3$基板であり、前記第１，第２絶縁物層がＳｉＯ$_2$膜からなり、ＳｉＯ$_2$膜の合計の規格化膜厚ＨＳ／λが０．１０～０．４０の範囲にあり、前記Ａｌよりも密度の大きい金属が密度５０００～１５０００ｋｇ／ｍ^{3}及びヤング率１．０×１０^{11}～２．０５×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が２０００～２８００ｍ／ｓである金属であり、前記電極の膜厚をＨ、弾性表面波の波長をλとしたときに、規格化膜厚Ｈ／λが０．０１～０．０８の範囲にある、請求項１，４～６のいずれかに記載の弾性表面波装置。
【請求項１９】
前記金属がＣｕである、請求項１８に記載の弾性表面波装置。
【請求項２０】
前記ＬｉＴａＯ$_3$基板のオイラー角及び前記ＳｉＯ$_2$の合計の規格化膜厚ＨＳ／λが、下記の表６に示されている組み合わせのいずれかである、請求項１８または１９に記載の弾性表面波装置。
【表６】

ＳｉＯ$_2$膜厚	ＬｉＴａＯ$_3$のオイラー角
０．１５～０．１８	(０±３，１１７～１３７，０±３)
０．１８～０．２３	(０±３，１１７～１３６，０±３)
０．２３～０．２８	(０±３，１１５～１３５，０±３)
０．２８～０．３３	(０±３，１１３～１３３，０±３)
０．３３～０．３８	(０±３，１１３～１３５，０±３)
０．３８～０．４	(０±３，１１３～１３２，０±３)

【請求項２１】
前記オイラー角（０±３°，θ，０±３°）のθが下記の式（２）の範囲にあることを特徴とする、請求項１８または１９に記載の弾性表面波装置。
$\theta_{min}-2° < \theta \leqq \theta_{min}+2°$　　式（２）
但し、式（２）中、θ_{min}は、ＩＤＴの規格化膜厚Ｈ／λが下記の（ａ）～（ｅ）の範囲の場合、それぞれ下記の式Ａ～Ｅで表される値である。
（ａ）０＜Ｈ／λ≦０．０１のとき
$\theta_{min}=-139.718\times HS^3+43.07132\times HS^2-20.568011\times HS+125.8314$　式Ａ（ｂ）０．０１＜Ｈ／λ≦０．０３のとき
$\theta_{min}=-139.660\times HS^3+46.02985\times HS^2-21.141500\times HS+127.4181$　式Ｂ（ｃ）０．０３＜Ｈ／λ≦０．０５のとき
$\theta_{min}=-139.607\times HS^3+48.98838\times HS^2-21.714900\times HS+129.0048$　式Ｃ（ｄ）０．０５＜Ｈ／λ≦０．０７のとき
$\theta_{min}=-112.068\times HS^3+39.60355\times HS^2-21.186000$

×ＨＳ＋１２９．９３９７　式Ｄ（ｅ）０．０７＜Ｈ／λ≦０．０９のとき
θ_{min}＝－１２６．９５４×$ＨＳ^3$＋６７．４０４８８×$ＨＳ^2$
－２９．４３２０００×ＨＳ＋１３１．５６８６　式Ｅ

【請求項２２】
前記$ＳｉＯ_2$膜の合計の規格化膜厚ＨＳ／λと、$ＬｉＴａＯ_3$基板のオイラー角が下記の表７に示す組み合わせのいずれかである、請求項１８または１９に記載の弾性表面波装置。

【表７】

$ＳｉＯ_2$膜厚	$ＬｉＴａＯ_3$のオイラー角
０．１５～０．１８	(０±３，１１７～１２５，０±３)
０．１８～０．２３	(０±３，１１７～１２５，０±３)
０．２３～０．２８	(０±３，１１５～１２５，０±３)
０．２８～０．３３	(０±３，１１３～１２５，０±３)
０．３３～０．３８	(０±３，１１３～１２５，０±３)
０．３８～０．４０	(０±３，１１３～１２５，０±３)

【請求項２３】
前記圧電性基板が、オイラー角（０±３°，１１２°～１３８°，０±３°）の$ＬｉＴａＯ_3$基板であり、前記第１，第２絶縁物層が$ＳｉＯ_2$膜からなり、$ＳｉＯ_2$膜の合計の規格化膜厚ＨＳ／λが０．１０～０．４０の範囲にあり、
前記Ａｌよりも密度の大きい金属が密度１５０００～２８０００ｋｇ／$ｍ^3$及びヤング率２．０×$１０^{１１}$～４．５×$１０^{１１}$Ｎ／$ｍ^2$あるいは横波音速が２８００～３５００ｍ／ｓである金属であり、前記電極の膜厚をＨ、弾性表面波の波長をλとしたときに、規格化膜厚Ｈ／λが０．０２５～０．０６の範囲にある、請求項１，４～６のいずれかに記載の弾性表面波装置。

【請求項２４】
前記金属がタングステンである、請求項２３に記載の弾性表面波装置。

【請求項２５】
前記ＩＤＴの規格化膜厚Ｈ／λが、０．０１２～０．０５３の範囲にある、請求項２３または２４に記載の弾性表面波装置。

【請求項２６】
前記ＩＤＴの規格化膜厚Ｈ／λが、０．０１５～０．０４２の範囲にある、請求項２５に記載の弾性表面波装置。

【請求項２７】
前記$ＬｉＴａＯ_3$基板が、オイラー角（０±３°，１１５°～１３５°，０±３°）の$ＬｉＴａＯ_3$基板である、請求項２３～２５のいずれかに記載の弾性表面波装置。

【請求項２８】
前記電極の規格化膜厚Ｈ／λが、０．０１２～０．０５３であり、前記$ＳｉＯ_2$膜の合計の規格化膜厚ＨＳ／λと、$ＬｉＴａＯ_3$基板のオイラー角が下記の表８に示す組み合わせのいずれかである、請求項２３または２４に記載の弾性表面波装置。

【表８】

電極のH/λ＝0.012～0.053のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角
0.1～0.15	(0±3,114.2～138,0±3)
0.15～0.2	(0±3,113～137.8,0±3)
0.2～0.3	(0±3,113～137.5,0±3)
0.3～0.35	(0±3,112.7～137,0±3)
0.35～0.4	(0±3,112.5～136,0±3)

【請求項２９】

前記電極の規格化膜厚Ｈ／λが、０．０１５～０．０４２であり、前記Ｓｉ$Ｏ_2$膜の合計の規格化膜厚ＨＳ／λと、ＬｉＴａ$Ｏ_3$基板のオイラー角が下記の表９に示す組み合わせのいずれかである、請求項２３または２４に記載の弾性表面波装置。

【表９】

電極のH/λ＝0.015～0.042のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角
0.1～0.15	(0±3,114.3～138,0±3)
0.15～0.2	(0±3,113～137.5,0±3)
0.2～0.3	(0±3,112.5～137,0±3)
0.3～0.35	(0±3,112.2～136.5,0±3)
0.35～0.4	(0±3,112～135.3,0±3)

【請求項３０】

前記圧電性基板が、オイラー角（０±３°，１０４°～１４８°，０±３°）のＬｉＴａ$Ｏ_3$基板であり、前記第１，第２絶縁物層がＳｉ$Ｏ_2$膜からなり、Ｓｉ$Ｏ_2$膜の合計の規格化膜厚ＨＳ／λが０．１０～０．４０の範囲にあり、

前記Ａｌよりも密度の大きい金属が密度１５０００～２３０００ｋｇ／$ｍ^3$及びヤング率１．０×$１０^{１１}$～２．０×$１０^{１１}$Ｎ／$ｍ^2$あるいは横波音速が２０００～２８００ｍ／ｓである金属であり、前記電極の膜厚をＨ、弾性表面波の波長をλとしたときに、規格化膜厚Ｈ／λが０．００４～０．０５５の範囲にある、請求項１，４～６のいずれかに記載の弾性表面波装置。

【請求項３１】

前記金属がタンタルである、請求項３０に記載の弾性表面波装置。

【請求項３２】

前記電極の規格化膜厚Ｈ／λが、０．０１～０．５５の範囲にある、請求項３０または３１に記載の弾性表面波装置。

【請求項３３】

前記電極の規格化膜厚Ｈ／λが、０．０１６～０．０４５の範囲にある、請求項３０または３１に記載の弾性表面波装置。

【請求項３４】

前記圧電性基板が、オイラー角（０±３°，１１１°～１４３°，０±３°）のＬｉＴａ$Ｏ_3$基板である、請求項３０～３２のいずれかに記載の弾性表面波装置。

【請求項３５】

前記電極の規格化膜厚Ｈ／λが、０．０１～０．０５５であり、前記Ｓｉ$Ｏ_2$膜の合計の規格化膜厚ＨＳ／λと、ＬｉＴａ$Ｏ_3$基板のオイラー角が下記の表１０に示す組み合わせのいずれかである、請求項３０または３１に記載の弾性表面波装置。

【表１０】

電極の H/λ＝0.01～0.055 のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角
0.1～0.15	(0±3, 110.5～148, 0±3)
0.15～0.2	(0±3, 108～147.5, 0±3)
0.2～0.3	(0±3, 105～148, 0±3)
0.3～0.35	(0±3, 104.5～148, 0±3)
0.35～0.4	(0±3, 104～145, 0±3)

【請求項３６】

前記電極の規格化膜厚Ｈ／λが０．０１６～０．０４５であり、前記ＳｉＯ$_2$膜の合計の規格化膜厚ＨＳ／λと、ＬｉＴａＯ$_3$基板のオイラー角が下記の表１１に示す組み合わせのいずれかである、請求項３０または３１に記載の弾性表面波装置。

【表１１】

電極の H/λ＝0.016～0.045 のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角
0.1～0.15	(0±3, 113～144, 0±3)
0.15～0.2	(0±3, 111～144, 0±3)
0.2～0.3	(0±3, 108～144, 0±3)
0.3～0.35	(0±3, 107.5～143, 0±3)
0.35～0.4	(0±3, 107～140.5, 0±3)

【請求項３７】

前記圧電性基板が、オイラー角（０±３°，９０°～１６９°，０±３°）のＬｉＴａＯ$_3$基板であり、前記第１，第２絶縁物層がＳｉＯ$_2$膜からなり、ＳｉＯ$_2$膜の合計の規格化膜厚ＨＳ／λが０．１０～０．４０の範囲にあり、

前記Ａｌよりも密度の大きい金属が密度１５０００～２３０００ｋｇ／ｍ^{3}及びヤング率１．０×１０^{11}～２．０×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が１０００～２０００ｍ／ｓの金属であり、前記電極の膜厚をＨ、弾性表面波の波長をλとしたときに、規格化膜厚Ｈ／λが０．００５～０．０５４の範囲にある、請求項１，４～６のいずれかに記載の弾性表面波装置。

【請求項３８】

前記金属が白金である、請求項３７に記載の弾性表面波装置。

【請求項３９】

前記圧電性基板のオイラー角が（０±３°，９０°～１５５°，０±３°）であり、前記電極の規格化膜厚Ｈ／λが０．０１～０．０４の範囲にある、請求項３７または３８に記載の弾性表面波装置。

【請求項４０】

前記ＬｉＴａＯ$_3$基板のオイラー角及び前記ＳｉＯ$_2$の合計の規格化膜厚ＨＳ／λが、下記の表１２に示されている組み合わせのいずれかである、請求項３９に記載の弾性表面波装置。

【表１２】

白金H/λ＝0.01～0.04のとき

SiO₂厚(Hs/λ)	オイラー角
0.1 ≦ Hs/λ＜0.15	(0±3°,90°～169°,0±3°)
0.15≦ Hs/λ＜0.2	(0±3°,90°～167°,0±3°)
0.20≦ Hs/λ＜0.25	(0±3°,90°～167°,0±3°)
0.25≦ Hs/λ＜0.3	(0±3°,90°～164°,0±3°)
0.3 ≦ Hs/λ＜0.4	(0±3°,90°～163°,0±3°)

【請求項４１】
前記圧電性基板のオイラー角が（０±３°，１０２°～１５０°，０±３°）であり、前記電極の規格化膜厚Ｈ／λが０．０１３～０．０３３の範囲にある、請求項３７または３８に記載の弾性表面波装置。
【請求項４２】
前記ＳｉＯ$_2$膜の合計の規格化膜厚ＨＳ／λと、ＬｉＴａＯ$_3$基板のオイラー角が下記の表１３に示す組み合わせのいずれかである、請求項４１に記載の弾性表面波装置。
【表１３】

白金H/λ＝0.013～0.033のとき

SiO₂厚(Hs/λ)	オイラー角
0.1 ≦ Hs/λ＜0.15	(0±3°,106°～155°,0±3°)
0.15≦ Hs/λ＜0.2	(0±3°,104°～155°,0±3°)
0.20≦ Hs/λ＜0.25	(0±3°,102°～155°,0±3°)
0.25≦ Hs/λ＜0.3	(0±3°,102°～154°,0±3°)
0.3 ≦ Hs/λ＜0.4	(0±3°,102°～153°,0±3°)

【請求項４３】
前記圧電性基板が、オイラー角（０±３°，１０４°～１５０°，０±３°）のＬｉＴａＯ$_3$基板であり、前記第１，第２絶縁物層がＳｉＯ$_2$膜からなり、その合計の規格化膜厚ＨＳ／λが０．１０～０．４０の範囲にあり、
前記Ａｌよりも密度の大きい金属が密度５０００～１５０００ｋｇ／ｍ^{3}及びヤング率２．０×１０^{11}～４．５×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が２８００～３５００ｍ／ｓの金属からなり、前記電極の膜厚をＨ、弾性表面波の波長をλとしたときに、規格化膜厚Ｈ／λが０．００８～０．０６の範囲にある、請求項１，４～６のいずれかに記載の弾性表面波装置。
【請求項４４】
前記金属がＮｉである、請求項４３に記載の弾性表面波装置。
【請求項４５】
前記電極の規格化膜厚Ｈ／λが０．０２～０．０６の範囲にある、請求項４４に記載の弾性表面波装置。
【請求項４６】
前記電極の規格化膜厚Ｈ／λが０．０２７～０．０６の範囲にある、請求項４４に記載の弾性表面波装置。
【請求項４７】
前記ＬｉＴａＯ$_3$基板のオイラー角と、前記ＳｉＯ$_2$膜の合計の規格化膜厚ＨＳ／λとが、下記の表１４に示す組み合わせのいずれかである、請求項４４に記載の弾性表面波装置。

【表１４】

SiO_2膜厚	オイラー角
0.1～0.2	(0±3°,106°～140°,0±3°)
0.2～0.3	(0±3°,105°～137°,0±3°)
0.3～0.4	(0±3°,104°～133°,0±3°)

【請求項４８】
前記金属がＭｏからなる、請求項４３に記載の弾性表面波装置。
【請求項４９】
前記電極の規格化膜厚Ｈ／λが０．０１７～０．０６の範囲にある、請求項４８に記載の弾性表面波装置。
【請求項５０】
前記電極の規格化膜厚Ｈ／λが０．０２３～０．０６の範囲にある、請求項４８に記載の弾性表面波装置。
【請求項５１】
前記ＬｉＴａ$Ｏ_3$基板のオイラー角と、前記Ｓｉ$Ｏ_2$膜の合計の規格化膜厚ＨＳ／λとが下記の表１５に示す組み合わせのいずれかである、請求項４８に記載の弾性表面波装置。
【表１５】

SiO_2膜厚	オイラー角
0.1～0.2	(0±3°,107°～141°,0±3°)
0.2～0.3	(0±3°,104°～141°,0±3°)
0.3～0.4	(0±3°,104°～138°,0±3°)

【請求項５２】
前記電極が、Ａｌよりも密度の大きい金属もしくは合金からなる主たる電極層と、他の金属からなる少なくとも１つの電極層との積層膜からなり、該電極の平均密度ρと、前記Ａｌよりも密度の大きい金属の密度をρ０とした場合、ρ０×０．７≦ρ≦ρ０×１．３である、請求項１，４～６のいずれかに記載の弾性表面波装置。
【請求項５３】
前記第２絶縁物層表面の凹凸が、前記電極の膜厚の３０％以下である、請求項１～５２のいずれかに記載の弾性表面波装置。
【請求項５４】
弾性表面波として漏洩タイプの弾性表面波を用いることを特徴とする、請求項１～５３のいずれかに記載の弾性表面波装置。
【請求項５５】
圧電性基板を用意する工程と、
前記圧電性基板の片面の全面に第１絶縁物層を形成する工程と、
少なくとも１つの電極を有する電極パターンを形成するためのレジストパターンを用いて前記電極が形成される部分の第１絶縁物層を除去するとともに、残りの領域に第１絶縁物層とレジストとの積層構造を残留させる工程と、
前記第１絶縁物層が除去されている領域に、Ａｌよりも高密度の金属または該金属を主成分とする合金からなる電極膜を第１絶縁物層と略等しい厚みに形成して少なくとも１つの電極を形成する工程と、
前記第１絶縁物層上に残留しているレジストを除去する工程と、
前記第１絶縁物層及び電極上を被覆するように第２絶縁物層を形成する工程とを備える、弾性表面波装置の製造方法。

【請求項５６】
前記電極を構成している金属もしくは合金の密度が、前記第１絶縁物層の密度の１．５倍以上である、請求項５５に記載の弾性表面波装置の製造方法。
【請求項５７】
圧電性基板を用意する工程と、
前記圧電性基板の片面の全面において第１絶縁物層を形成する工程と、
少なくとも１つの電極パターンを形成するためのレジストパターンを用いて前記電極が形成される部分の領域の第１絶縁物層を除去し、残りの領域に第１絶縁物層とレジストとの積層構造を残留させる工程と、
前記第１絶縁物層が除去されている領域に、電極を形成するための金属もしくは合金膜を形成して電極を形成する工程と、
前記電極を形成した後に、該電極を構成する金属もしくは合金よりも耐腐食性に優れた金属もしくは合金からなる保護金属膜を該電極の全面に形成して前記保護金属膜を前記第１絶縁物層の高さと略等しい高さに形成する工程と、
前記第１絶縁物層上のレジスト及び該レジスト上に積層されている保護金属膜を除去する工程と、
前記電極上に形成された保護金属膜及び前記第１絶縁物層を覆うように、第２絶縁物層を形成する工程とを備える、弾性表面波装置の製造方法。
【請求項５８】
前記電極及び保護金属膜からなる積層構造の平均密度が、第１絶縁物層の密度の１．５倍以上となるように、前記電極構成金属もしくは合金と、前記保護金属膜を構成する金属もしくは合金が選ばれる、請求項５７に記載の弾性表面波装置の製造方法。
【請求項５９】
圧電性基板を用意する工程と、
前記圧電性基板上に電極を形成する工程と、
前記電極を覆うように絶縁物層を形成する工程と、
前記電極が存在する部分と存在しない部分の上方における絶縁物層の凹凸を平坦化する工程とを備える、弾性表面波装置の製造方法。
【請求項６０】
前記平坦化工程が、エッチバック、逆スパッタまたは研磨により行われる、請求項５９に記載の弾性表面波装置の製造方法。
【請求項６１】
前記電極を構成する金属としてＡｕ，Ｃｕ，Ａｇ，Ｗ，Ｔａ，Ｐｔ，Ｎｉ及びＭｏ並びにこれらの金属を主成分とする合金からなる群から選択された１種を用い、前記絶縁物層としてSiO_2を用いる、請求項５５～５９に記載の弾性表面波装置の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、例えば共振子や帯域フィルタなどに用いられる弾性表面波装置及びその製造方法に関し、より詳細には、ＩＤＴ電極を被覆するように絶縁物層が形成されている構造を備えた弾性表面波装置及びその製造方法に関する。
【０００２】
【従来の技術】
移動体通信システムに用いられるＤＰＸやＲＦフィルタでは、広帯域かつ良好な温度特性の双方が満たされることが求められている。従来、ＤＰＸやＲＦフィルタに使用されてきた弾性表面波装置では、３６°～５０°回転Ｙ板Ｘ伝搬$LiTaO_3$からなる圧電性基板が用いられている。この圧電性基板は、周波数温度係数が－４０～－３０ＰＰｍ／℃程度であった。温度特性を改善するために、圧電性基板上においてＩＤＴ電極を被覆するように正の周波数温度係数を有するSiO_2膜を成膜する方法が知られている。図１０９にこの種の弾性表面波装置の製造方法の一例を示す。

【０００３】
図１０９（ａ）に示すように、圧電性基板５１上に、ＩＤＴ電極が形成される部分を除いてレジストパターン５２が形成される。次に、図１０９（ｂ）に示すように、全面にＩＤＴ電極を形成するための電極膜５３が形成される。しかる後、レジスト剥離液を用いて、レジスト５２及びレジスト５２上に付着している金属膜が除去される。このようにして、図１０９（ｃ）に示すように、ＩＤＴ電極５３Ａが形成される。次に、図１０９（ｄ）に示すように、ＩＤＴ電極５３Ａを被覆するように、SiO_2膜５４が成膜される。
【０００４】
他方、上記周波数温度特性の改善とは別の目的で、弾性表面波装置のＩＤＴ電極を被覆するように絶縁性または反導電性の保護膜が形成されている弾性表面波装置の製造方法が下記特許文献１に開示されている。図１１０は、この先行技術に記載の表面波装置を示す模式的断面図である。弾性表面波装置６１では、圧電基板６２上に、ＡｌまたはＡｌを主成分とする合金からなるＩＤＴ電極６３が形成されている。ＩＤＴ電極６３の設けられている領域以外の領域には、絶縁性または反導電性の電極指間膜６４が形成されている。また、ＩＤＴ電極６３及び電極指間膜６４を被覆するように、絶縁性または反導電性の保護膜６５が形成されている。この先行技術に記載の弾性表面波装置６１では、上記電極指間膜６４及び保護膜６５が、SiO_2などの絶縁物やシリコーンなどの反導電性材料により構成される旨が記載されている。ここでは、上記電極指間膜６３の形成により、圧電基板６１の有する焦電性に起因する電極指間の放電による特性の劣化が抑制されるとされている。
【０００５】
他方、下記の特許文献２には、水晶またはニオブ酸リチウムからなる圧電基板上に、アルミニウムや金などの金属からなる電極が形成されており、さらにSiO_2膜を形成した後、該SiO_2膜を平坦化してなる１ポート型弾性表面波伝共振子が開示されている。ここでは、平坦化により良好な共振特性が得られるとされている。
【０００６】
【特許文献１】
特開平１１－１８６８６６号公報
【特許文献２】
特開平６－２５８３５５号公報
【０００７】
【発明が解決しようとする課題】
図１０９に示したように、従来の周波数温度特性を改善するためにSiO_2膜を成膜してなる弾性表面波装置の製造方法では、ＩＤＴ電極５３Ａが存在する部分と、存在しない部分とで、SiO_2膜５４の表面の高さが異なることになる。従って、上記SiO_2膜５４表面の凹凸の存在により、挿入損失が劣化するという問題があった。また、ＩＤＴ電極の膜厚が大きくなるにつれて、この凹凸は大きくなる。従って、ＩＤＴ電極の膜厚を厚くすることができなかった。
【０００８】
他方、文献１に記載の弾性表面波装置では、ＩＤＴ電極６３の電極指間に電極指間膜６４が形成された後に、保護膜６５が形成されている。従って、保護膜６５の表面を平坦化することができる。
【０００９】
しかしながら、文献１に記載の構成では、ＩＤＴ電極６３はＡｌまたはＡｌを主成分とする合金により構成されていた。このＩＤＴ電極６３に接するように電極指間膜６４が形成されていたが、ＩＤＴ電極６３において十分な反射係数を得ることができなかった。そのため、例えば共振特性などにリップルが生じがちであるという問題があった。
【００１０】
さらに、文献１に記載の製造方法では、保護膜６５を形成するに先だち、電極指間膜６４上に形成されたレジストをレジスト剥離液を用いて除去しなければならないが、この際に

、ＩＤＴ電極６３がレジスト剥離液で腐食される恐れがあった。従って、ＩＤＴ電極を構成する金属として、腐食され易い金属を用いることができなかった。すなわち、ＩＤＴ電極構成金属の種類に制約があった。

【００１１】

他方、前述した特許文献２に記載の１ポート型弾性表面波共振子では、圧電基板として水晶またはニオブ酸リチウムを用いること、電極がアルミニウムまたは金などからなることが示されているものの、具体的な実施例では、水晶基板上にＡｌからなる電極を形成した例のみが示されている。すなわち、他の基板材料や他の金属材料を用いた弾性表面波装置については特に言及されていない。

【００１２】

本発明の目的は、上述した従来技術の現状に鑑み、ＩＤＴ電極の電極指間及びＩＤＴ電極上に絶縁物層が形成されている弾性表面波装置及びその製造方法であって、ＩＤＴ電極の反射係数が十分に大きく、共振特性などに表れるリップルによる特性の劣化が生じ難く、従って、良好な共振特性やフィルタ特性を有する弾性表面波装置及びその製造方法を提供することにある。

【００１３】

本発明の他の目的は、ＩＤＴ電極の反射係数が十分に大きく良好な特性を有するだけでなく、ＩＤＴ電極を構成する金属材料の選択の制約が少なく、ＩＤＴ電極の腐食による悪影響が生じ難い弾性表面波装置及びその製造方法を提供することにある。

【００１４】

本発明のさらに他の目的は、ＩＤＴ電極の反射係数が十分に大きく、良好な特性を有し、かつＩＤＴ電極の腐食による特性の劣化が生じ難いだけでなく、さらに周波数温度特性が良好な弾性表面波装置及びその製造方法を提供することにある。

【００１５】

【課題を解決するための手段】

上述したように、特許文献２では、SiO_2膜を平坦化することにより良好な共振特性が得られることが示されている。そこで、本願発明者らは、広帯域のフィルタを得るべく、圧電基板として、電気機械結合係数が大きな$LiTaO_3$基板を用い、その他は特許文献２に記載の構造と同様にして１ポート型弾性表面波共振子を作製し、特性を調査した。すなわち、$LiTaO_3$基板上に、Ａｌからなる電極を形成し、SiO_2膜を形成し、該SiO_2膜の表面を平坦化した。しかしながら、SiO_2膜を形成した後に、特性が大きく劣化し、実用し得るものではないことを見出した。

【００１６】

電気機械結合係数が水晶に比べて大きい$LiTaO_3$基板や$LiNbO_3$基板を用いると、比帯域幅は格段に大きくなる。しかしながら、本願発明者らが詳細な検討を行った結果、図２及び図３に示すように、$LiTaO_3$基板上にＡｌからなる電極を形成し、さらにSiO_2膜を形成した場合、SiO_2膜の表面を平坦化することにより、反射係数が０．０２程度まで激減することがわかった。なお、図２及び図３は、オイラー角（０°，１２６°，０°）の$LiTaO_3$基板上にアルミニウム、金または白金からなるＩＤＴ電極を種々の厚みで形成し、さらにSiO_2膜を形成してなる弾性表面波装置の電極膜厚Ｈ／λと、反射係数との関係を示す図である。なお、図２及び図３における実線はSiO_2膜の表面を図２及び図３中に模式的に示すように平坦化していない場合の反射係数の変化を示し、破線はSiO_2膜の表面を平坦化した場合の反射係数の変化を示す。

【００１７】

図２及び図３から明らかなように、従来のＡｌからなる電極を用いた場合には、SiO_2膜の表面を平坦化することにより、電極膜厚の如何に関わらず反射係数は０．０２程度まで激減することがわかる。このため、十分なストップバンドが得られなくなり、反共振周波数近傍に鋭いリップルが生じると考えられる。

【００１８】

また、従来、反射係数は電極膜厚が増大するにつれて大きくなることが知られている。し

かしながら、図２及び図３から明らかなように、Ａｌからなる電極を用いた場合には、電極の膜厚を大きくしたとしても、ＳｉＯ$_2$膜の表面が平坦化された場合には、反射係数は増大しないことがわかる。

【００１９】
これに対して、図２及び図３から明らかなように、ＡｕやＰｔからなる電極を形成した場合には、ＳｉＯ$_2$膜の弾性表面波を平坦化した場合においても、電極の膜厚が増大するにつれて、反射係数が大きくなることがわかる。本願発明者らは、このような知見に基づき、種々検討した結果、本発明をなすに至ったものである。

【００２０】
本願の第１の発明によれば、圧電性基板と、前記圧電性基板上に形成されており、Ａｌよりも高密度の金属または該金属を主成分とする合金からなる少なくとも１つのＩＤＴ電極と、前記少なくとも１つのＩＤＴ電極が形成されている領域を除いた残りの領域において、前記ＩＤＴ電極と略等しい膜厚に形成された第１絶縁物層と、前記ＩＤＴ電極及び第１絶縁物層を被覆するように形成された第２絶縁物層とを備え、上記ＩＤＴ電極の密度が、第１絶縁物層の密度の１．５倍以上とされている弾性表面波装置が提供される。第１の発明では、共振特性やフィルタ特性などに表れるリップルが帯域外に移動されると共に、リップルが抑圧される。従って、良好な特性を実現することができる。

【００２１】
本願の第２の発明の広い局面によれば、圧電性基板と、前記圧電性基板上に形成された少なくとも１つのＩＤＴ電極と、前記ＩＤＴ電極上に形成されており、かつＩＤＴ電極を構成する金属もしくは合金よりも耐腐食性に優れた金属もしくは合金からなる保護金属膜と、前記少なくとも１つのＩＤＴ電極が形成されている領域を除いた残りの領域において、前記ＩＤＴ電極と保護金属膜との合計の膜厚と略等しい膜厚を有するように形成された第１絶縁物層と、前記保護金属膜及び第１絶縁物層を被覆するように形成された第２絶縁物層とを備える、弾性表面波装置が提供される。

【００２２】
第２の発明のある特定の局面では、上記ＩＤＴ電極及び保護金属膜からなる積層構造の平均密度が、第１絶縁物層の密度の１．５倍以上とされており、それによって共振特性やフィルタ特性上に表れる不要リップルが帯域外にシフトされ、かつ共振される。

【００２３】
第１，第２の発明のある特定の局面では、上記第１，第２の絶縁物層がＳｉＯ$_2$により形成され、それによって周波数温度特性が良好な弾性表面波装置を提供することができる。

【００２４】
第１，第２の発明に係る弾性表面波装置は、好ましくは、弾性表面波の反射を利用した弾性表面波装置である。弾性表面波の反射を利用する構造としては、特に限定されず、圧電性基板の対向２端面の反射を利用した端面反射型弾性表面波装置が構成されてもよく、あるいはＩＤＴの弾性表面波伝搬方向外側に反射器を設けた弾性表面波装置であってもよい。

【００２５】
第１，第２の発明に係る弾性表面波装置は、様々な弾性表面波共振子や弾性表面波フィルタに用いることができる。このような弾性表面波共振子は、１ポート型共振子であってもよく、２ポート型共振子であってもよく、また弾性表面波フィルタは、２ポート型共振子フィルタであってもよく、ラダー型フィルタまたはラチス型フィルタなどであってもよい。

【００２６】
第１，第２の発明に係る弾性表面波装置のある特定の局面では、上記電極がＩＤＴ電極である。ＩＤＴ電極は、一方向性電極であってもよく、それによって挿入損失を低減することができる。

【００２７】
また、上記電極は反射器であってもよい。

第１，第２の発明に係る弾性表面波装置のある特定の局面では、上記電極が、ＩＤＴ電極及び反射器電極である。

【００２８】

第１，第２の発明のある特定の局面では、前記圧電性基板が、オイラー角（０±３°，１０４°～１４０°，０±３°）の$LiTaO_3$基板であり、前記第１，第２の絶縁物層がSiO_2より構成されており、第１，第２絶縁物層を構成しているSiO_2膜の合計膜厚をＨＳ、弾性表面波の波長をλとしたときに、ＨＳ／λが０．０３～０．４５の範囲とされており、前記電極の厚みをＨ、弾性表面波の波長をλとしたときに、電極の規格化膜厚Ｈ／λが、下記の式（１）を満たす値とされている。

$0.005 \leq H/\lambda \leq 0.00025 \times \rho^2 - 0.01056 \times \rho + 0.16473$（但し、ρは電極の平均密度）　式（１）

【００２９】

前述したように、第１の発明では、電極を構成する金属として、

金属が用いられる。このような金属としては、Ａｕ、Ａｇ、Ｃｕ、Ｗ、Ｔａ、Ｐｔ、ＮｉまたはＭｏなどが挙げられる。

【００３０】

本発明においては、後述するように、これらの金属もしくはこれらの金属を主体とする合金、あるいはこれらの金属もしくは合金からなる主たる金属膜と、他の金属からなる少なくとも１層の金属膜との従たる積層膜により電極が構成されてもよい。この場合、金属の種類に応じて電極の規格化膜厚Ｈ／λ及び圧電性基板のオイラー角及び第１，第２の絶縁物層をSiO_2膜から構成した場合の該SiO_2膜の合計の規格化膜厚ＨＳ／λが特定の範囲とされ、電気機械結合係数及び反射係数を高めることができ、かつ良好な周波数温度特性を実現することができる。また、上記各範囲を選択することにより、減衰定数の低下も図ることができる。

【００３１】

本願の第３の発明は、第１の発明に係る弾性表面波装置の製造方法であって、圧電性基板を用意する工程と、前記圧電性基板の片面の全面に第１絶縁物層を形成する工程と、少なくとも１つのＩＤＴ電極を有する電極パターンを形成するためのレジストパターンを用いて前記ＩＤＴ電極が形成される部分の第１絶縁物層を除去するとともに、残りの領域に第１絶縁物層とレジストとの積層構造を残留させせる工程と、前記第１絶縁物層が除去されている領域に、Ａｌよりも高密度の金属または該金属を主成分とする合金からなる電極膜を第１絶縁物層と略等しい厚みに形成して少なくとも１つのＩＤＴ電極を形成する工程と、前記第１絶縁物層上に残留しているレジストを除去する工程と、前記第１絶縁物層及びＩＤＴ電極上を被覆するように第２絶縁物層を形成する工程とを備えることを特徴とする。

【００３２】

第３の発明に係る弾性表面波装置の製造方法においても、好ましくは、上記ＩＤＴ電極を構成する金属もしくは合金の密度は、第１絶縁物層の密度の１．５倍以上とされ、共振特性やフィルタ特性上に表れる不要リップルが帯域外にシフトされ、かつ共振される。

【００３３】

本願の第４の発明は、弾性表面波装置の製造方法であって、第２の発明に係る弾性表面波装置を得るためのものである。第４の発明は、圧電性基板を用意する工程と、前記圧電性基板の片面の全面において第１絶縁物層を形成する工程と、少なくとも１つのＩＤＴ電極パターンを形成するためのレジストパターンを用いて前記電極が形成される部分の領域の第１絶縁物層を除去し、残りの領域に第１絶縁物層とレジストとの積層構造を残留させる工程と、前記第１絶縁物層が除去されている領域に、ＩＤＴ電極を形成するための金属もしくは合金膜を形成して、ＩＤＴ電極を形成する工程と、前記ＩＤＴ電極を形成した後に、該ＩＤＴ電極を構成する金属もしくは合金よりも耐腐食性に優れた金属もしくは合金からなる保護金属膜を該ＩＤＴ電極の全面に形成して前記保護金属膜を前記第１絶縁物層の高さと略等しい高さに形成する工程と、前記第１絶縁物層上のレジスト及び該レジスト上に積層されている保護金属膜を除去する工程と、前記ＩＤＴ電極上に形成された保護金属

膜及び前記第１絶縁物層を覆うように、第２絶縁物層を形成する工程とを備えることを特徴とする。

【００３４】

第４の発明においても、第２の発明と同様に、ＩＤＴ電極及び保護金属膜からなる積層構造の平均密度は、好ましくは、第１絶縁物層の密度の１．５倍以上とされ、共振特性やフィルタ特性上に表れる不要リップルが帯域外にシフトされ、かつ共振される。

【００３５】

本願の第５の発明は、圧電性基板を用意する工程と、前記圧電性基板上に電極を形成する工程と、前記電極を覆うように絶縁物層を形成する工程と、前記電極が存在する部分と存在しない部分の上方における絶縁物層の凹凸を平坦化する工程とを備える、弾性表面波装置の製造方法である。

【００３６】

第５の発明においては、好ましくは、上記平坦化工程は、エッチバック、逆スパッタまたは研磨により行われる。

【００３７】

【発明の実施の形態】

以下、図面を参照しつつ、本発明の具体的な実施例を説明することにより、本発明を明らかにする。

【００３８】

図１及び図６を参照して、本発明の第１の実施例に係る弾性表面波装置の製造方法を説明する。

図１（ａ）に示すように、まず、圧電性基板として、$LiTaO_3$基板１を用意する。本実施例では、３６°Ｙ板Ｘ伝搬、オイラー角で（０°，１２６°，０°）の$LiTaO_3$基板が用いられる。もっとも、圧電性基板としては、他の結晶方位の$LiTaO_3$基板を用いてもよく、あるいは他の圧電単結晶からなるものを用いてもよい。また、絶縁性基板上に圧電性薄膜を積層してなる圧電性基板を用いてもよい。なお、オイラー角（φ，θ，ψ）のθ＝カット角＋９０°の関係がある。

【００３９】

$LiTaO_3$基板１上に、全面に第１絶縁物層２を形成する。本実施例では、第１絶縁物層２は、SiO_2膜により形成されている。

第１絶縁物層２の形成方法は、印刷、蒸着、またはスパッタリングなどの適宜の方法により行われ得る。また、第１絶縁物層２の厚みは、後で形成されるＩＤＴ電極の厚みと等しくされている。

【００４０】

次に、図１（ｂ）に示すように、フォトリソグラフィー技術を用いて、レジストパターン３を形成する。レジストパターン３では、ＩＤＴが形成される領域を除いてレジストが位置するようにレジストパターン３が構成されている。

【００４１】

次に、図１（ｃ）に矢印で示すようにイオンビームを照射する反応性イオンエッチング法（ＲＩＥ）などにより、第１絶縁物層２の内、レジスト３の下方に位置している部分を除いた残りの部分を除去する。

【００４２】

フッ素系のガスによるＲＩＥによってSiO_2をエッチングした場合、重合反応により残渣が生じる場合がある。この場合、ＲＩＥを行った後、ＢＨＦ（バッファードフッ酸）等により処理することで対応できる。

【００４３】

しかる後、Ｃｕ膜とＴｉ膜を、第１絶縁物層２と等しい厚みに成膜する。図１（ｄ）に示すように、第１絶縁物層２が除去されている領域、すなわちＩＤＴが形成される領域にＣｕ膜４が付与され、同時にレジストパターン３上にもＣｕ膜４が付与される。次に、全面保護金属膜としてＴｉ膜５を形成する。図１（ｅ）に示すように、Ｔｉ膜５は、ＩＤＴ電

極４Ａの上面と、レジストパターン３上のＣｕ膜４上に付与されることになる。従って、ＩＤＴ電極４Ａは、側面が第１絶縁物層２で被覆され、上面がＴｉ膜５により被覆されている。このようにして、ＩＤＴ電極４Ａと保護金属膜とが形成され、ＩＤＴ電極４Ａの厚みと保護金属膜としてのＴｉ膜５の厚みの合計の厚みと第１絶縁物層２の厚みとが同じ厚みを有するように構成される。

【００４４】

しかる後、レジスト剥離液を用い、レジストパターン３を除去する。このようにして、図１（ｆ）に示すように、第１絶縁物層２が設けられている領域を除いた残りの領域にＩＤＴ電極４Ａが形成されており、ＩＤＴ電極４Ａの上面がＴｉ膜５により被覆されている構造が得られる。

【００４５】

しかる後、図１（ｇ）に示すように、全面に第２絶縁物層６としてSiO_2膜を形成する。

このようにして、図６に示す１ポート型の弾性表面波共振子１１を得た。

【００４６】

なお、図１（ａ）～（ｇ）では、ＩＤＴ電極４Ａが形成されている部分のみが抜き出されて説明された。しかしながら、図６に示されているように、弾性表面波共振子１１は、ＩＤＴ電極４Ａの弾性表面波伝搬方向両側に反射器１２，１３を備えている。反射器１２，１３もまた、ＩＤＴ電極４Ａと同じ工程により形成される。

【００４７】

上記実施例では、１ポート型弾性表面波共振子１１が構成されているため、$LiTaO_3$基板１上に、１個のＩＤＴ電極４Ａが形成されていたが、弾性表面波装置の用途に応じて、複数のＩＤＴ電極が形成されてもよく、また上記のように反射器がＩＤＴと同一工程により形成されてもよく、反射器が設けられずともよい。

【００４８】

比較のために、図１０９に示した従来のSiO_2膜を有する弾性表面波装置の製造方法に準じて、１ポート型弾性表面波共振子を作製した。もっとも、この比較例においても、基板材料としては、３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°））の$LiTaO_3$基板を用い、ＩＤＴ電極はＣｕにより形成した。図１０９に示した製造方法から明らかなように、ＩＤＴ電極５３Ａが形成された後に、SiO_2膜５４が形成されるため、SiO_2膜５４の表面に凹凸が生じざるを得なかった。比較例において、ＣｕからなるＩＤＴ電極の規格化膜厚h/λ（ｈはＩＤＴ電極の厚み、λは弾性表面波の波長）を０．０４２とし、SiO_2膜の規格化膜厚Hs/λ（HsはSiO_2膜の厚み）を、０．１１、０．２２及び０．３３とした場合のインピーダンス特性及び位相特性を図４に示す。図４から明らかなように、SiO_2膜の規格化膜厚Hs/λが大きくなるにつれて、反共振点におけるインピーダンスと共振点におけるインピーダンスとの比であるインピーダンス比が小さくなることがわかる。

【００４９】

また、図５は、比較例で製作された弾性表面波共振子のSiO_2膜の規格化膜厚Hs/λと、共振子のＭＦ（Ｆｉｇｕｒｅ ｏｆ Ｍｅｒｉｔ）との関係を示す。図５から明らかなように、SiO_2膜の膜厚が厚くなるにつれて、ＭＦが低下することがわかる。

【００５０】

すなわち、図１０９に示した従来法に準じて、ＩＤＴ電極及びSiO_2膜を形成した場合、たとえＣｕによりＩＤＴ電極を形成したとしても、SiO_2膜の膜厚が厚くなるにつれて、特性が大きく劣化した。これは、SiO_2膜表面に前述した凹凸が生じざるを得ないことによると考えられる。

【００５１】

これに対して、本実施例の製造方法によれば、SiO_2膜の膜厚を増加させた場合でも特性の劣化が生じ難いこと、図７～９に示す。

図７は、上記実施例に従って弾性表面波共振子１１を得た場合のSiO_2膜の厚み、すな

わち、第２絶縁物層６の厚みを変化させた場合のインピーダンス特性及び位相特性の変化示す図である。また、図８及び図９の破線は、それぞれ、実施例においてＳｉＯ$_2$膜の膜厚ＨＳ／λを変化させた場合の共振子のγ及びＭＦの変化を示す図である。

【００５２】

なお、図８及び図９においては、上記比較例の結果を、実線で示す。

図７を、図４と比較すれば明らかなように、上記実施例では、比較例の場合に比べて、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λを増加させても、インピーダンスの低下が生じ難いことがわかる。

【００５３】

また、図８及び図９の結果から明らかなように、比較例に比べて、実施例の製造方法によれば、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λの増加に伴う特性の劣化が抑制されることがわかる。

【００５４】

すなわち、本実施例の製造方法によれば、上記のようにＳｉＯ$_2$膜の膜厚を増加させた場合であっても、インピーダンス比の低下が生じ難く、特性の劣化を抑制することができる。

【００５５】

他方、図１０は、ＳｉＯ$_2$膜の膜厚と、比較例及び実施例の製造方法で得られた弾性表面波共振子の周波数温度特性ＴＣＦとの関係を示す図である。

図１０において、実線が比較例、破線が実施例の結果を示す。

【００５６】

図１０から明らかなように、実施例の製造方法によれば、ＳｉＯ$_2$膜の膜厚を増加させた場合に、周波数温度特性ＴＣＦを膜厚増に応じて理想的に改善し得ることがわかる。

【００５７】

従って、上記実施例の製造方法を採用することにより、特性の劣化が生じ難く、温度特性を効果的に改善し得る弾性表面波共振子を提供し得ることがわかる。

加えて、本実施例の製造方法では、ＩＤＴ電極は、Ａｌよりも高密度のＣｕにより構成されている。従って、ＩＤＴ電極４Ａは十分な反射係数を有し、共振特性上に表れる所望でないリップルを抑制することができる。これを、以下において説明する。

【００５８】

Ｃｕに代えてＡｌ膜を用いたことを除いては、上記実施例と同様にして第２の比較例の弾性表面波共振子を作製した。但し、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λは０．０８とした。すなわち、第１の絶縁物層の厚みの規格化膜厚を０．０８とした。このようにして得られた弾性表面波共振子のインピーダンス及び位相特性を図１１に実線で示す。

【００５９】

また、ＳｉＯ$_2$膜を形成しなかったことを除いては、第２の比較例と同様にして構成された弾性表面波共振子のインピーダンス及び位相特性を図１１に破線で示す。

【００６０】

図１１の実線から明らかなように、上記実施例の製造方法に従ったとしても、ＩＤＴ電極をＡｌで形成し、かつＳｉＯ$_2$膜を形成した場合には、図１１の矢印Ａで示す大きなリップルが共振点と反共振点との間において表れることがわかる。また、このようなリップルは、ＳｉＯ$_2$を有しない弾性表面波共振子では表れていないことがわかる。

【００６１】

従って、ＳｉＯ$_2$膜の形成により周波数温度特性の改善等を図ろうとしても、ＡｌによりＩＤＴ電極を形成した場合には、上記リップルＡが表れ、特性の劣化を引き起こすことがわかる。本願発明者は、この点につきさらに検討した結果、ＩＤＴ電極として、Ａｌよりも高密度の金属を用いれば、ＩＤＴ電極の反射係数を高めることができ、それによって上記リップルＡを抑制し得ることを見出した。

【００６２】

すなわち、上記実施例と同様の製造方法に従って、但し、ＩＤＴ電極４を構成する金属の

密度を種々異ならせ、上記実施例と同様にして弾性表面波共振子を作製した。このようにして得られた弾性表面波共振子のインピーダンス特性を図１２（ａ）～（ｅ）に示す。図１２（ａ）～（ｅ）は、それぞれ、ＩＤＴ電極及び保護金属膜の積層構造の平均密度ρ_1の第１絶縁物層の密度ρ_2に対する比ρ_1／ρ_2が、２．５、２．０、１．５、１．２及び１．０の場合の結果を示す。

【００６３】

図１２（ａ）～（ｅ）から明らかなように、図１２（ａ）～（ｃ）では、上記リップルＡが帯域外にシフトされ、さらに図１２（ａ）では、上記リップルＡが著しく抑圧されていることがわかる。

【００６４】

従って、図１２の結果から、ＩＤＴ電極及び保護金属膜の積層構造の第１絶縁物層に対する密度比を１．５倍以上とすれば、上記リップルＡを共振周波数－反共振周波数の帯域の外側にシフトさせ、良好な特性の得られることがわかる。また、より好ましくは、上記密度比を２．５倍以上とすれば、リップル自体を小さくし得ることがわかる。

【００６５】

図１２（ａ）～（ｅ）では、上記実施例に従って、ＩＤＴ電極４Ａ上に、Ｔｉ膜が積層されていたため、上記平均密度が用いられたが、本発明においては、ＩＤＴ電極４Ａ上に、保護金属膜が設けられずともよい。その場合には、ＩＤＴ電極４Ａの厚みを第１の絶縁物層の厚みと同じにして、ＩＤＴ電極の密度の第１絶縁物層の密度に対する比を１．５倍以上とすることが好ましく、より好ましくは２．５倍以上とすればよく、上記と同様の効果の得られることが確かめられた。

【００６６】

従って、SiO_2膜によりＩＤＴ電極を被覆してなる弾性表面波共振子において、ＩＤＴ電極の密度あるいはＩＤＴ電極と保護金属膜との積層体の平均密度を、ＩＤＴ電極の側方に位置する第１絶縁物層の密度よりも大きくすれば、ＩＤＴ電極の反射係数を高めることができ、それによって共振点－反共振点間に表れる特性の劣化を抑制し得ることがわかる。

【００６７】

なお、Ａｌより高密度の金属もしくは合金としては、Ｃｕの他、Ａｇ，Ａｕなどやこれらを主体とする合金が挙げられる。

また、好ましくは、上記実施例のように、ＩＤＴ電極上に、保護金属膜を積層した構造とすれば、図１（ａ）～（ｇ）に示した製造方法から明らかなように、レジストパターン８を剥離する際に、ＩＤＴ電極４Ａの側面が第１絶縁物層２により覆われており、かつ上面が保護金属膜６により覆われているため、ＩＤＴ電極４Ａの腐食を防止することができる。よって、より一層良好な特性を有する弾性表面波共振子を提供し得ることがわかる。

【００６８】

さらに、SiO_2以外のSiO_xN_yなどの他の温度特性改善効果のある絶縁性材料により第１，第２の絶縁物層を形成してもよい。また、第１，第２の絶縁物層は異なる絶縁性材料で構成されてもよく、上記のように等しい材料で構成されてもよい。

【００６９】

図１３は、オイラー角（０°，１２６°，０°）の$LiTaO_3$基板上に、様々な厚みで様々な金属を用いてＩＤＴ電極を形成した場合のＩＤＴの規格化膜厚Ｈ／λと、電気機械結合係数の関係を示す図である。

【００７０】

図１３から得られる、Ａｌに比べて電気機械結合係数が大きくなる電極の規格化膜厚を各金属について調べたところ、図１４に示す結果が得られた。すなわち、図１４は、上記$LiTaO_3$基板上に、様々な密度の金属からなるＩＤＴ電極を形成した場合に、上述したようにＡｌからなるＩＤＴ電極を形成した場合に比べて電気機械結合係数が大きくなる電極膜厚範囲を示す図である。

【００７１】

図１４において、各金属からなる電極の膜厚範囲のうち上限が、Ａｌよりも電気機械結合係数が大きくなる範囲の限界値であり、各金属の電極膜厚範囲の下限は作製限界を示す。電気機械結合係数の大きな電極膜厚の範囲をｙ、密度をｘとして上限を二次式で近似すると、$y=0.00025x^{2}-0.01056x+0.16473$となる。

【００７２】

従って、後述の各電極材料別の具体的な実施例の説明から明らかなように、１４°～５０°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１０４°～１４０°，０°））の$LiTaO_3$からなる圧電基板上に電極が形成されており、さらにSiO_2膜は規格化膜厚Ｈｓ／λ０．０３～０．４５の範囲で形成されている構造において、電極の規格化膜厚Ｈ／λが、

$0.005 \leqq H/\lambda \leqq 0.00025 \times \rho^{2}-0.01056 \times \rho+0.16473$ 式（１）

を満たす場合、図１４の結果から明らかなように電気機械結合係数を高めることができる。なお、ρは電極の平均密度を示す。

【００７３】

本発明においては、電極は、上述したアルミニウムよりも密度の高い金属を用いて構成されていることを特徴とする。この場合、電極は、アルミニウムよりも密度の高い金属から構成されていてもよく、あるいはアルミニウムを主体とする合金で構成されていてもよい。また、アルミニウムもしくはアルミニウムを主成分とする合金からなる主たる金属膜と、該金属膜と異なる金属からなる従たる金属膜の積層構造で構成されていてもよい。積層膜により電極が構成されている場合、電極の平均密度をρ、主たる電極層の金属の密度をρ０とした場合、$\rho0 \times 0.7 \leqq \rho \leqq \rho0 \times 1.3$を満足する平均密度であればよい。

【００７４】

また、本発明においては、上記のように第２絶縁物層の表面が平坦化されるが、この平坦化とは、電極の膜厚の３０％以下の凹凸を有するものであればよい。３０％を超えると、平坦化による効果が十分に得られないことがある。

【００７５】

さらに、上記のように第２絶縁物層の平坦化は、様々な方法で行われる。例えば、エッチバックによる平坦化方法、逆スパッタ効果による斜入射効果を利用した平坦化方法、絶縁物層表面を研磨する方法、あるいは電極を研磨する方法などが挙げられる。これらの方法は２種以上が併用されてもよい。これらの方法の詳細を、図１０２～図１０５を説明する。

【００７６】

図１０２（ａ）～（ｃ）は、エッチバック方法により絶縁物層表面を平坦化する方法である。まず、図１０２（ａ）に示すように、圧電性基板４１上に、電極４２が形成され、しかる後絶縁物層４３が形成される。図１０２（ｂ）に示すように、絶縁物層４３上にレジスト４４がスピンコーティング等により形成される。レジスト４４の表面は平坦である。従って、この状態から、反応性イオンエッチングによりエッチングすることにより、すなわちエッチバックにより、SiO_2などからなる絶縁物層４３の表面を平坦化することができる（図１０２（ｃ））。

【００７７】

図１０３（ａ）～（ｄ）は、逆スパッタ法を説明するための各模式的断面図である。ここでは、圧電性基板４１上に電極４２が形成され、しかる後絶縁物層４３が形成される。そして、アルゴンイオンなどをスパッタリングにより絶縁物層４３の表面に照射する。このイオンは、基板４１をスパッタするために用いられている。イオンが基板に衝突し、スパッタリングを行う場合、平坦な面に入射するよりも、斜めの面に入射する場合の方が大きなスパッタ効果が得られる。これは、斜入射効果として知られている。この効果により、絶縁物層４３の表面が、図１０３（ｂ）～（ｄ）に示すように、スパッタリングを進めるに従って平坦化される。

【００７８】

図１０４（ａ）及び（ｂ）は、絶縁物層を研磨することにより平坦化する方法を説明する

ための模式的断面図である。図１０４（ａ）に示すように、基板４１上に、電極４２及び絶縁物層４８を形成した後、機械的または化学的に研磨することにより、絶縁物層４８の表面を平坦化することができる。
【００７９】
図１０５（ａ）～（ｃ）は、電極を研磨することにより平坦化を図る方法である。ここでは、図１０５（ａ）に示すように、基板４１上に、第１絶縁物層４５を形成した後、電極材料からなる金属膜４２Ａを全面に蒸着等により形成される。しかる後、図１０５（ｂ）に示すように、金属膜４２Ａを機械的または化学的に研磨することにより、電極４２と、電極４２が設けられている領域の周囲の領域に形成された第１絶縁物層４５を形成する。このようにして、第１絶縁物層４５及び電極４２の上面が面一とされ、平坦化される。しかる後、図１０５（ｃ）に示すように、第２絶縁物４６を形成することにより、表面が平坦な絶縁物層を形成することができる。
【００８０】
本発明は、様々な弾性表面波装置に適用することができる。このような弾性表面波装置の例を、図１０６（ａ），（ｂ）～図１０８に示す。図１０６（ａ）及び（ｂ）は、それぞれ、１ポート型弾性表面波共振子４７及び２ポート型弾性表面波共振子４８の電極構造を示す模式的平面図である。また、図１０６（ｂ）に示す２ポート型弾性表面波共振子４８と同じ電極構造を用いて２ポート型弾性表面波共振子フィルタを構成してもよい。
【００８１】
さらに、図１０７及び図１０８は、それぞれ、ラダー型フィルタ及びラチス型フィルタの電極構造を示す模式的平面図である。図１０７及び図１０８に示すラダー型フィルタ４９ａ及びラチス型フィルタ４９ｂのような電極構造を圧電性基板上に形成することにより、本発明に従ってラダー型フィルタ及びラチス型フィルタを構成することができる。
【００８２】
もっとも、本発明は、図１０６及び図１０７に示した電極構造を有する弾性表面波装置に限らず、様々な弾性表面波装置に適用することができる。
また、本発明に係る弾性表面波装置では、好ましくは、漏洩弾性波を用いた弾性表面波装置が構成される。特開平６－１６４３０６号公報には、Ａｕなどの重い金属からなる電極を有する弾性表面波装置であって、伝搬減衰がないラブ波を用いた弾性表面波装置が開示されている。ここでは、重い金属を電極として用いることにより、伝搬する弾性表面波の音速が基板の遅い横波バルク波よりも遅くされ、それによって漏洩成分がなくなり、非漏洩の弾性表面波としてのラブ波が利用されている。
【００８３】
しかしながら、上記ラブ波では、音速が必然的に遅くなり、それに伴ってＩＤＴのピッチが小さくならざるを得ない。従って、加工の難易度が高くなり、加工精度が劣化する。加えて、ＩＤＴの線幅も小さくなり、抵抗による損失も増大する。従って、損失が大きくならざるを得ない。
【００８４】
これに対して、本発明では、上記のようなラブ波を用いた弾性表面波装置とは異なり、Ａｌよりも重い金属からなる電極を用いているにも関わらず、音速の速い漏洩弾性表面波を好適に利用することができ、その場合であっても伝搬損失の低減を図ることができる。従って、低損失の弾性表面波装置を構成することができる。
【００８５】
以下、上述した結果をふまえて、電極をＡｌよりも密度の大きい金属で構成した場合の個々の例につき、金属材料ごとに説明を行うこととする。
なお、本発明で用いられるＡｌよりも密度の大きい金属とは、（１）密度１５０００～２３０００ｋｇ／ｍ^{3}及びヤング率０．５×１０^{11}～１．０×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が１０００～２０００ｍ／ｓである金属、例えばＡｕ、（２）密度５０００～１５０００ｋｇ／ｍ^{3}及びヤング率０．５×１０^{11}～１．０×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が１０００～２０００ｍ／ｓである金属、例えばＡｇ、（３）密度５０００～１

５０００ｋｇ／ｍ^{3}及びヤング率１．０×１０^{11}～２．０５×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が２０００～２８００ｍ／ｓである金属、例えばＣｕ、（４）密度１５０００～２３０００ｋｇ／ｍ^{3}及びヤング率２．０×１０^{11}～４．５×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が２８００～３５００ｍ／ｓである金属、例えばタングステン、（５）密度１５０００～２３０００ｋｇ／ｍ^{3}及びヤング率１．０×１０^{11}～２．０×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が２０００～２８００ｍ／ｓである金属、例えばタンタル、（６）密度１５０００～２３０００ｋｇ／ｍ^{3}及びヤング率１．０×１０^{11}～２．０×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が１０００～２０００ｍ／ｓである金属、例えば白金、（７）密度５０００～１５０００ｋｇ／ｍ^{3}及びヤング率２．０×１０^{11}～４．５×１０^{11}Ｎ／ｍ^{2}あるいは横波音速が２８００～３５００ｍ／ｓである金属、例えばＮｉ，Ｍｏが挙げられる。

【００８６】

〔電極がＡｕを主体とする実施例〕

図１５は、本発明の他の実施例に係る弾性表面波装置としての縦結合共振子フィルタを説明するための平面図である。

【００８７】

弾性表面波装置２１は、ＬｉＴａＯ$_3$基板２２の上面に、ＩＤＴ２３ａ，２３ｂ及び反射器２４ａ，２４ｂを形成した構造を有する。また、ＩＤＴ２３ａ，２３ｂ及び反射器２４ａ，２４ｂを覆うようにＳｉＯ$_2$膜１５が形成されている。なお、ＬｉＴａＯ$_3$基板２２としては、２５°～５８°回転Ｙ板Ｘ伝搬（オイラー角（０°，１１５°～１４８°，０°））ＬｉＴａＯ$_3$基板が用いられる。この範囲外のカット角の回転Ｙ板Ｘ伝搬ＬｉＴａＯ$_3$基板では、減衰定数が大きく、ＴＣＦも悪化する。

【００８８】

ＩＤＴ２３ａ，２３ｂ及び反射器２４ａ，２４ｂは、Ａｌに比べて密度の高い金属により構成される。このような金属としては、Ａｕ、Ｐｔ、Ｗ、Ｔａ、Ａｇ、Ｍｏ、Ｃｕ、Ｎｉ、Ｃｏ、Ｃｒ、Ｆｅ、Ｍｎ、Ｚｎ及びＴｉからなる群から選択された少なくとも１種の金属または該少なくともその１種を主成分とする合金が挙げられる。

【００８９】

上記のように、Ａｌに比べて密度の高い金属によりＩＤＴ２３ａ，２３ｂ及び反射器２４ａ，２４ｂが構成されているため、ＩＤＴ２３ａ，２３ｂ及び反射器２４ａ，２４ｂの膜厚をＡｌを用いた場合に比べて薄くした場合であっても、図１６、図１７に示すように、電気機械結合係数及び反射係数を高めることができる。

【００９０】

そして、上記のように電極膜厚を薄くすることができる。ＳｉＯ$_2$膜２５の厚みについては、後述の実験例から明らかなように、弾性表面波の波長で規格化された膜厚ＨＳ／λが０．０３～０．４５の範囲であることが好ましい。なお、ＨＳは第１，第２絶縁物層をＳｉＯ$_2$で構成した場合の合計の厚み、λは弾性表面波の波長を示す。この範囲にすることで、ＳｉＯ$_2$膜がない場合より減衰定数を大幅に小さくすることができ、低ロス化が可能となる。

【００９１】

ＩＤＴを構成する材料によっても異なるが、例えばＡｕ膜からなる場合、ＩＤＴ２３ａ，２３ｂの弾性表面波の波長で規格化された膜厚は０．０１３～０．０３０が好ましい。Ａｕ膜が薄いと、ＩＤＴが引き回り抵抗をもつので、より好ましくは０．０２１～０．０３が好ましい。

【００９２】

本発明の係る弾性表面波装置では、上記のように、ＬｉＴａＯ$_3$基板２２上にＡｌよりも密度の大きい金属によりＩＤＴ２３ａ，２３ｂが構成されており、該ＩＤＴ２３ａ，２３ｂの電極膜厚を薄くすることができる。よって、良好な特性を有し、かつＳｉＯ$_2$膜２５の形成により良好な周波数温度特性が実現される。これを、具体的な例に基づき説明する。

【００９３】
３６°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１２６°，０°）の$LiTaO_3$基板上に、Ａｌからなる IDT を形成した場合、及びＡｕ、Ｔａ、Ａｇ、Ｃｒ、Ｗ、Ｃｕ、Ｚｎ、Ｍｏ、Ｎｉからなる IDT の種々の膜厚で形成した場合の電気機械結合係数K_{saw}及び減衰定数（α）と反射係数｜ｒｅｆ｜の変化を図１６，図１８及び図１７にそれぞれ示す。なお、数値計算はＪ．Ｊ．Ｃｈａｍｐｂｅｌｌ ａｎｄ Ｗ．Ｒ．Ｊｏｎｅｓ：ＩＥＥＥ Ｔｒａｎｓ．Ｓｏｎｉｃ＆Ｕｌｔｒａｓｏｎ．ＳＵ－１５．Ｐ２０９（１９６８）の方法に従い、電極は全面一様として計算を行った。

【００９４】
図１６から明らかなように、Ａｌからなる IDT において、規格化された膜厚Ｈ／λが０．１０の場合、電気機械結合係数K_{saw}は約０．２７である。なお、Ｈは厚み、λは弾性表面波の波長を示す。これに対して、Ａｕ、Ｔａ、Ａｇ、Ｃｒ、Ｗ、Ｃｕ、Ｚｎ、Ｍｏ、Ｎｉからなる IDT ではＨ／λを０．０１３～０．０３５の範囲とした場合、より大きな電気機械結合係数K_{saw}を実現することができる。しかしながら、図１８から明らかなように、膜厚Ｈ／λの如何に関わらず、Ａｌからなる IDT では減衰定数αがほぼ０であるのに対し、Ａｕ、Ｔａ、Ａｇ、Ｃｒ、Ｗ、Ｃｕ、Ｚｎ、Ｍｏ、Ｎｉからなる IDT では、減衰定数が非常に大きくなる。

【００９５】
図２５は、オイラー角で（０°，θ，０°）の$LiTaO_3$基板上に、Ａｕからなる IDT 及びSiO_2膜を形成した構造における、θと、電気機械結合係数との関係を示す図である。ここでは、Ａｕからなる IDT の規格化膜厚を、０．０２２、０．０２５及び０．０３０とした場合、並びにSiO_2膜の規格化膜厚ＨＳ／λを、０．００（SiO_2膜を成膜せず）、０．１０、０．２０、０．３０及び０．４５と変化させた。

【００９６】
図２５から明らかなように、SiO_2膜が厚くなるに連れて、電気機械結合係数K_{saw}が小さくなることがわかる。また、後述するように、SiO_2膜による特性の劣化を抑制するために、IDT の膜厚を薄くした場合を考えてみる。前述の図１６から明らかなように、従来のＡｌからなる IDT において規格化膜厚を０．０４まで薄くした場合、SiO_2膜が形成されていない場合でも、電気機械結合係数K_{saw}は０．２４５と小さくなる。また、Ａｌからなる IDT の規格化膜厚を０．０４とし、SiO_2膜を形成した場合には、電気機械結合係数K_{saw}はさらに小さくなり、実用上広帯域化が困難となる。

【００９７】
これに対して、図２５から明らかなように、Ａｕからなる IDT を形成し、SiO_2膜を形成した構造では、オイラー角のθを１２８．５°以下とすることにより、SiO_2膜の規格化膜厚ＨＳ／λを０．４５程度とした場合であっても、電気機械結合係数K_{saw}は０．２４５以上となることがわかる。また、規格化膜厚が０．３０程度のSiO_2膜を形成した場合には、オイラー角のθを１３２°以下とすることにより、電気機械結合係数K_{saw}を０．２４５以上とすることができる。なお、後述するように、オイラー角のθが１１５°よりも小さい場合には、減衰定数が大きくなり、実用的ではない。従って、２５°～４２°回転Ｙ板Ｘ伝搬（オイラー角で（０±３°，１１５°～１３２°，０±３°））、より好ましくは２５°～３８．５°回転Ｙ板Ｘ伝搬（オイラー角で（０±３°，１１５°～１２８．５°，０±３°））の$LiTaO_3$基板を用いることが好適であることがわかる。

【００９８】
他方、３６°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１２６°，０°）の$LiTaO_3$基板の周波数温度特性（ＴＣＦ）は－３０～－４０ＰＰｍ／℃であり、十分ではない。この周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内となるように改善するために、３６°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１２６°，０°）の$LiTaO_3$基板上に、Ａｕからなる IDT を形成し、さらにSiO_2膜を種々の膜厚で形成した場合の周波数温度特性の変化を図１９に示す。なお、図１９において、○は理論値を示し、×は実験値を示す

。ここでは、ＡｕからなるＩＤＴの規格化膜厚はＨ／λ＝０．０２０である。

【００９９】

図１９から明らかなように、ＳｉＯ$_2$膜の形成により、周波数温度特性が改善されることがわかる。特に、ＳｉＯ$_2$膜の規格化された膜厚ＨＳ／λが０．２５の近傍の場合、ＴＣＦが０となり好ましいことがわかる。

【０１００】

また、回転Ｙ板Ｘ伝搬ＬｉＴａＯ$_3$基板として、カット角が３６°（オイラー角で（０°，１２６°，０°））及び３８°（オイラー角で（０°，１２８°，０°））の２種類のオイラー角のＬｉＴａＯ$_3$基板を用い、ＡｕからなるＩＤＴの膜厚及びＳｉＯ$_2$膜の膜厚を種々変化させた場合の減衰定数αの変化を数値解析した。結果を図２０及び図２１に示す。なお、図２０及び図２１のＡｕの膜厚値はＨ／λである。図２０及び図２１から明らかなように、ＡｕからなるＩＤＴの膜厚の如何に関わらず、ＳｉＯ$_2$膜の膜厚を選択すれば、減衰定数αを小さくし得ることがわかる。すなわち、図２０及び図２１から明らかなように、ＳｉＯ$_2$膜の膜厚ＨＳ／λを０．０３～０．４５、より好ましくは０．１０～０．３５の範囲とすれば、いずれかのオイラー角のＬｉＴａＯ$_3$基板及びいずれの膜厚のＡｕからなるＩＤＴを形成した場合においても、減衰定数αが非常に小さくされ得ることがわかる。

【０１０１】

さらに、図１７により、ＡｕからなるＩＤＴを用いると、薄い膜厚でもＡｌに比べて十分大きな反射係数が得られていることがわかる。

従って、上記図１６～図２１の結果から、ＬｉＴａＯ$_3$基板上に膜厚Ｈ／λが０．０１３～０．０３０のＡｕからなるＩＤＴを形成した場合、ＳｉＯ$_2$膜の膜厚ＨＳ／λを０．０３～０．４５の範囲とすれば、大きな電気機械結合係数が得られるだけでなく、減衰定数αを非常に小さくし、かつ、十分な反射係数を得ることができることができる。

【０１０２】

上述した実施例において、カット角３６°（オイラー角で（０°，１２６°，０°））のＬｉＴａＯ$_3$基板上に、Ｈ／λ＝０．０２０の規格化膜厚のＡｕからなるＩＤＴを形成し、さらに規格化膜厚ＨＳ／λ＝０．１のＳｉＯ$_2$膜を形成してなる実施例の弾性表面波装置１１の減衰量－周波数特性を図２２に破線で示す。また、比較のために、該弾性表面波フィルタにおいて、ＳｉＯ$_2$膜を形成する前の構造の減衰量周波数特性を実線で示す。

【０１０３】

図２２から明らかなように、ＳｉＯ$_2$膜の形成により電気機械結合係数が０．３０から０．２８に若干小さくなるにもかかわらず、挿入損失が改善されていることがわかる。従って、図２２から明らかなように、ＳｉＯ$_2$膜を上記特定の範囲の厚みとすれば、減衰定数αが小さくなることが裏付けられる。

【０１０４】

本願発明者は、上述した知見に基づき、様々なオイラー角の回転Ｙ板Ｘ伝搬ＬｉＴａＯ$_3$基板上に、規格化膜厚が０．０２であるＡｕからなるＩＤＴを形成し、さらに様々な厚みのＳｉＯ$_2$膜を形成して１ポート型弾性表面波共振子を試作した。この場合、ＳｉＯ$_2$膜の規格化膜厚は、０．１０、０．２０、０．３０及び０．４５とした。このようにして得られた各１ポート型弾性表面波共振子のＱ値を測定した。結果を図２６に示す。

【０１０５】

一般に、共振子のＱ値が大きい程、フィルタとして用いた場合の通過帯域から減衰域にかけてのフィルタ特性の急峻性が高められる。従って、急峻なフィルタを必要とするときには、Ｑ値は大きい方が望ましい。図２６から明らかなように、ＳｉＯ$_2$膜の膜厚の如何に関わらず、カット角が４８°回転Ｙ板、オイラー角で（０°，１３８°，０°）付近でＱ値が最大となり、カット角４２°～５８°（オイラー角で（０°，１３２°～１４８°，０°））の範囲でＱ値が比較的大きいことがわかる。

【０１０６】

従って、図２６から明らかなように、カット角４２°～５８°回転Ｙ板（オイラー角で（

0°，132°～148°，0°））のLiTaO$_3$基板を用い、該LiTaO$_3$基板上に、Auよりも密度の高い金属からなる少なくとも1つのIDTを形成し、さらにSiO$_2$膜をIDTを覆うようにLiTaO$_3$基板上に形成した構造とすることにより、大きなQ値を得ることができることがわかる。好ましくは、図26から明らかなように、カット角は46．5°～53°回転Y板（オイラー角で（0°，136．5°～143°，0°））とされる。

【0107】

なお、本発明においては、IDTの上面に密着層が形成されてもよい。すなわち、図27（a）に示すように、LiTaO$_3$基板32上に、IDT33が形成されており、IDT33の上面に、密着層34が作製されていてもよい。密着層34は、IDT33とSiO$_2$膜35との間に配置されている。密着層34は、SiO$_2$膜35のIDT33に対する密着強度を高めるために設けられている。このような密着層34を構成する材料としては、PdまたはAl、あるいはこれらの合金が好適に用いられる。また、金属に限らず、ZnOなどの圧電材料や、Ta$_2$O$_3$もしくはAl$_2$O$_3$などの他のセラミックスを用いて密着層34を構成してもよい。密着層34の形成により、Alよりも密度が高い金属からなるIDT33とSiO$_2$膜35との密着強度が高められ、それによってSiO$_2$膜の膜剥がれが抑制される。

【0108】

密着層34の厚みは、弾性表面波全般への影響を与えないためには、弾性表面波の波長の1％程度以下の厚みとすることが望ましい。また、図27（a）では、IDT33の上面に密着層34が形成されていたが、図27（b）に示すように、LiTaO$_3$基板上にSiO$_2$膜35との界面にも密着層34Aを形成してもよい。さらに図27（c）に示すように、密着層34は、IDT33の上面だけでなく側面をも覆うように形成されてもよい。

【0109】

また、SiO$_2$膜の密着強度を改善する他の構成として、IDT以外のバスバーや外部との接続用パッドを含む複数の電極において、該複数の電極を、それぞれ、IDTと同じ材料からなる下地金属層と、下地金属層上に積層されており、AlもしくはAl合金からなる上層金属層からなるものを用いてもよい。すなわち、例えば図15に示した反射器24a，24bを構成する電極膜として、IDT23a，23bと同じ材料からなる下地金属層と、該下地金属層上に、Al膜を積層してもよい。このように、AlやAl合金からなる上層金属層を設けることにより、SiO$_2$膜との密着強度が高められる。また、電極コストを低減することもでき、さらにAlウェッジボンド性を高めることもできる。

【0110】

なお、上記IDT以外の電極としては、反射器、バスバー、外部との電極的接続用パッドだけでなく、必要に応じて形成される引き回し電極などが挙げられる。また、上記Al合金としては、特に限定されないが、Al－Ti合金、Al－Ni－Cr合金などが挙げられる。

【0111】

なお、上述した実験例の場合以外のオイラー角の回転Y板X伝搬LiTaO$_3$基板を用いた場合においても、AuからなるIDTを形成した場合において、減衰定数αを最小とするSiO$_2$膜の膜厚が存在することが本願発明者等により確かめられている。すなわち、SiO$_2$膜の膜厚HS／λを特定の範囲とすれば、上記実験例の場合と同様に、減衰定数αを小さくすることができる。一方、SiO$_2$膜の膜厚HS／λを0．1～0．45としたときのオイラー角とαの関係を図28～36に示す。これらの図からSiO$_2$膜の膜厚が厚くなるに従い、αが極小となるオイラー角のθが小さくなることも明らかとなった。従って、他のオイラー角の回転Y板X伝搬LiTaO$_3$基板を用いた場合であっても、AuからなるIDTを形成し、SiO$_2$膜を積層した構造において、SiO$_2$膜の厚みを選択することにより、従来の弾性表面波装置に比べて、周波数温度特性TCFが半分以下と良好であり、電気機械結合係数が大きく、かつ反射係数が大きな弾性表面波装置を構成す

ることができる。このような効果を発現し得るＬｉＴａＯ$_3$基板のオイラー角と、ＡｕからなるＩＤＴの電極膜厚と、ＳｉＯ$_2$膜の膜厚の好ましい組み合わせは、以下の表１６及び表１７で示される通りであることが確かめられている。

【０１１２】

【表１６】

ｵｲﾗｰ角 (0±3°，θ，0±3°) のθ	Ａｕ膜厚	ＳｉＯ$_2$膜厚
120.0°≦θ＜123.0°	0.013～0.018	0.15～0.45
123.0°≦θ＜124.5°	0.013～0.022	0.10～0.40
124.5°≦θ＜125.5°	0.013～0.025	0.07～0.40
125.5°≦θ＜127.5°	0.013～0.025	0.06～0.40
127.5°≦θ＜129.0°	0.013～0.028	0.04～0.40
129.0°≦θ＜130.0°	0.017～0.030	0.03～0.42
130.0°≦θ＜131.5°	0.017～0.030	0.03～0.42
131.5°≦θ＜133.0°	0.018～0.028	0.05～0.33
133.0°≦θ＜135.0°	0.018～0.030	0.05～0.30
135.0°≦θ≦137.0°	0.019～0.032	0.05～0.25
137.0°≦θ≦140.0°	0.019～0.032	0.05～0.25

【０１１３】

【表１７】

ｵｲﾗｰ角 (0±3°，θ，0±3°) のθ	Ａｕ膜厚	ＳｉＯ$_2$膜厚
129.0°≦θ＜130.0°	0.022～0.028	0.04～0.40
130.0°≦θ＜131.5°	0.022～0.028	0.04～0.40
131.5°≦θ＜133.0°	0.022～0.028	0.05～0.33
133.0°≦θ＜135.0°	0.022～0.030	0.05～0.30
135.0°≦θ＜137.0°	0.022～0.032	0.05～0.25
137.0°≦θ≦140.0°	0.022～0.032	0.05～0.25

【０１１４】

なお、オイラー角のθが所望の角度から－２°～＋４°ずれることがある。このずれは本願明細書における計算結果が基板の全面に金属膜を形成したものから計算されたものであるため、実際の弾性表面波装置では上記の範囲で誤差が発生することもある。

【０１１５】

本発明に係る弾性表面波装置の製造に際しては、回転Ｙ板Ｘ伝搬ＬｉＴａＯ$_3$基板上にＡｕを主成分とする金属からなるＩＤＴを形成した後、その状態において周波数調整を行ない、しかる後減衰定数αを小さくし得る範囲の膜厚のＳｉＯ$_2$膜を成膜することが望ましい。これを、図２３及び図２４を参照して説明する。図２３は、３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°））ＬｉＴａＯ$_3$基板上に、種々の膜厚のＡｕからなるＩＤＴ及び種々の膜厚のＳｉＯ$_2$膜を形成した場合の漏洩弾性表面波の音速の変化を示す。また、図２４は、同じオイラー角のＬｉＴａＯ$_3$基板上に、種々の膜厚のＡｕからなるＩＤＴを形成した場合、その上に形成されるＳｉＯ$_2$膜の規格化膜厚を変化させた場

合の漏洩弾性表面波の音速の変化を示す。図２３と図２４を比較すれば明らかなように、Ａｕの膜厚を変化させせた場合の方が、SiO_2膜の膜厚を変化させせた場合よりも弾性表面波の音速の変化がはるかに大きい。従って、SiO_2膜の形成に先立ち、周波数調整が、行われることが望ましく、例えば、レーザーエッチングやイオンエッチングなどによりＡｕからなるＩＤＴを形成した後に周波数調整を行うことが望ましい。特に好ましくは、Ａｕの規格化膜厚が、０．０１５～０．０３の範囲であれば、SiO_2膜による音速の変化が小さくなり、SiO_2膜のばらつきによる周波数変動を小さくすることができる。

【０１１６】

なお、オイラー角のθが所望の角度から－２°～＋４°ずれることがある。このずれは本願明細書における計算結果が基板の全面に金属膜を形成したものから計算されたものであるため、実際の弾性表面波装置では上記の範囲で誤差が発生することもある。

【０１１７】

また、製造の際、オイラー角のφとψは０°から±３°ばらつくが、特性は０°のものとほぼ同じ特性が得られた。

〔電極材料がＡｇの実施例〕

本実施例の弾性表面波装置は、前述した図１５に示した弾性表面波装置２１と同様である。もっとも、本実施例では、ＩＤＴ２３ａ，２３ｂがＡｇにより構成されている。

【０１１８】

後述するように、ＩＤＴ２３ａ，２３ｂがＡｇからなる場合には、ＩＤＴ２３ａ，２３ｂの弾性表面波の波長で規格化された膜厚Ｈ／λは０．０１～０．０８が好ましい。

【０１１９】

本発明の係る弾性表面波装置では、上記のように、$LiTaO_3$基板２２上にＡｇによりＩＤＴ２３ａ，２３ｂが構成されており、該ＩＤＴ２３ａ，２３ｂの電極膜厚を薄くすることができる。オイラー角の$LiTaO_3$基板を用いるため減衰定数を大幅に小さくすることができ、低ロス化が可能となる。また、SiO_2膜２５の形成により、良好な周波数温度特性が実現される。これを、具体的な実験例に基づき説明する。

【０１２０】

$LiTaO_3$基板を伝わる弾性表面波には、レイリー波の他に漏洩弾性表面波（ＬＳＡＷ）がある。漏洩弾性表面波は、レイリー波に比べて音速が早く、電気機械結合係数が大きいが、エネルギーを基板内に放射しつつ伝搬する。従って、漏洩弾性表面波は、伝搬ロスの原因となる減衰定数を有する。

【０１２１】

図３６は、３６°回転Ｙ板Ｘ伝搬$LiTaO_3$基板（オイラー角で（０°，１２６°，０°））上に、ＡｇからなるＩＤＴを形成した場合のＡｇ膜の規格化膜厚Ｈ／λと、電気機械結合係数K_{saw}との関係を示す。なお、λは、弾性表面波装置の中心周波数における波長を示すものとする。

【０１２２】

図３６から明らかなように、Ａｇ膜の膜厚Ｈ／λが０．０１～０．０８の範囲において、電気機械結合係数K_{saw}が、Ａｇ膜が形成されていない場合（Ｈ／λ＝０）に比べて１．５倍以上となることがわかる。また、Ａｇ膜の膜厚がＨ／λ＝０．０２～０．０６の範囲では、Ａｇ膜が形成されていない場合に比べて、電気機械結合係数K_{saw}は１．７倍以上の値となり、Ａｇ膜の膜厚Ｈ／λが０．０３～０．０５の範囲では、Ａｇ膜が形成されていない場合の１．８倍以上の値となることがわかる。

【０１２３】

Ａｇ膜の規格化膜厚Ｈ／λが０．０８を超えると、Ａｇ膜からなるＩＤＴの作製が困難となる。従って、大きな電気機械結合係数を得ることができ、かつＩＤＴの作製が容易であるため、Ａｇ膜からなるＩＤＴの厚みは、０．０１～０．０８の範囲であることが望ましく、より好ましくは０．０２～０．０６、さらに好ましくは０．０３～０．０５の範囲とされる。

【０１２４】

次に、ＬｉＴａＯ$_3$基板上に、ＳｉＯ$_2$膜を成膜した場合の周波数温度係数ＴＣＦの変化を図３７に示す。図３７は、オイラー角（０°，１１８°，０°）、（０°，１２６°，０°）及び（０°，１２９°，０°）の３種類のＬｉＴａＯ$_3$基板上にＳｉＯ$_2$膜が形成されている場合のＳｉＯ$_2$膜の規格化膜厚ＨＳ／λとＴＣＦとの関係を示す。なお、ここでは電極は形成されていない。

【０１２５】

図３７から明らかなように、θが１１８°、１２６°及び１２９°のいずれの場合においても、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λが０．１５～０．４５の範囲において、ＴＣＦが－２０～＋２０ＰＰｍ／℃の範囲となることがわかる。もっとも、ＳｉＯ$_2$膜の成膜には時間を要するため、ＳｉＯ$_2$膜の膜厚ＨＳ／λは０．１５～０．４０が望ましい。

【０１２６】

ＬｉＴａＯ$_3$基板上にＳｉＯ$_2$膜を成膜することにより、レイリー波などのＴＣＦが改善されることは知られていたが、ＬｉＴａＯ$_3$基板上に、Ａｇからなる電極を形成し、さらにＳｉＯ$_2$膜を積層した構造において、実際に、Ａｇからなる電極の膜厚、ＳｉＯ$_2$の膜厚、オイラー角、及び漏洩弾性波の減衰定数を考慮して実験された報告はない。

【０１２７】

図３８は、オイラー角（０°，１２０°，０°）のＬｉＴａＯ$_3$基板上に規格化膜厚Ｈ／λが０．１０以下のＡｇからなる電極と、規格化膜厚ＨＳ／λが０～０．５のＳｉＯ$_2$膜を形成した場合における減衰定数αの変化を示す。図３８から明らかなように、ＳｉＯ$_2$膜の膜厚ＨＳ／λが０．２～０．４０、Ａｇ膜の膜厚Ｈ／λが０．０１～０．１０である場合に減衰定数αが小さくなっていることがわかる。

【０１２８】

他方、図３９は、（０°，１４０°，０°）のオイラー角のＬｉＴａＯ$_3$基板上には、規格化膜厚Ｈ／λが０～０．１０のＡｇ膜を形成し、さらに、規格化膜厚ＨＳ／λが０～０．５のＳｉＯ$_2$膜を形成した場合の減衰定数αの変化を示す。

【０１２９】

図３９から明らかなように、オイラー角でθ＝１４０°のＬｉＴａＯ$_3$基板を用いた場合には、Ａｇ膜の膜厚が０．０６以下においてＳｉＯ$_2$膜の膜厚を上記のように変化させたとしても、減衰定数αは大きいことがわかる。

【０１３０】

すなわち、良好なＴＣＦ、大きな電気機械結合係数及び小さな減衰定数を実現するには、ＬｉＴａＯ$_3$基板のカット角すなわちオイラー角と、ＳｉＯ$_2$膜の膜厚と、Ａｇからなる電極の膜厚とをそれぞれ最適なように組み合わせることが必要となることがわかる。

【０１３１】

図４０～図４７は、それぞれ、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λが、０．１、０．１５、０．２、０．２５、０．３、０．３５、０．４または０．４５であり、規格化膜厚Ｈ／λが０．１以下のＡｇ膜をＬｉＴａＯ$_3$基板上に形成した場合のθと減衰定数αとの関係を示す。

【０１３２】

図４０～図４７から明らかなように、Ａｇ膜の厚みＨ／λを０．０１～０．０８とした場合、ＳｉＯ$_2$膜の厚みと、オイラー角のθとが、下記の表１８に示すいずれかの組み合わせとなるように選択されれば、周波数温度特性ＴＣＦが良好であり、電気機械結合係数が大きく、かつ減衰定数αを効果的に抑制し得ることがわかる。望ましくは、下記の表１８の右側のより好ましいオイラー角を選択することにより、より一層良好な特性を得ることができる。

【０１３３】

【表１８】

Ａｇ膜厚H／λ：０．０１～０．０８のとき

SiO_2膜厚	$LiTaO_3$のオイラー角	より好ましいオイラー角
０．１５～０．１８	０±３，１１７～１３７，０±３	０±３，１２０～１３５，０±３
０．１８～０．２３	０±３，１１７～１３６，０±３	０±３，１１８～１３３，０±３
０．２３～０．２８	０±３，１１５～１３５，０±３	０±３，１１７～１３３，０±３
０．２８～０．３３	０±３，１１３～１３３，０±３	０±３，１１５～１３２，０±３
０．３３～０．３８	０±３，１１３～１３５，０±３	０±３，１１５～１３３，０±３
０．３８～０．４０	０±３，１１３～１３２，０±３	０±３，１１５～１３０，０±３

【０１８４】
また、より好ましくは、Ａｇ膜の規格化膜厚が０．０２～０．０６の場合には、SiO_2膜の厚みと、オイラー角のθとが、下記の表１９に示すいずれかの組み合わせとなるように選択されれば、より一層好ましく、さらに望ましくは、下記の表１９の右側のより好ましいオイラー角を選択することにより、より一層良好な特性を得ることができる。
【０１８５】
【表１９】

Ａｇ膜厚H／λ：０．０２～０．０６のとき

SiO_2膜厚	$LiTaO_3$のオイラー角	より好ましいオイラー角
０．１５～０．１８	０±３，１２０～１３３，０±３	０±３，１２２～１３０，０±３
０．１８～０．２３	０±３，１２０～１３７，０±３	０±３，１２２～１３６，０±３
０．２３～０．２８	０±３，１２０～１３５，０±３	０±３，１２２～１３３，０±３
０．２８～０．３３	０±３，１１８～１３５，０±３	０±３，１２０～１３３，０±３
０．３３～０．３８	０±３，１１５～１３３，０±３	０±３，１１７～１３０，０±３
０．３８～０．４０	０±３，１１３～１３０，０±３	０±３，１１５～１２８，０±３

【０１８６】
さらに好ましくは、Ａｇ膜の規格化膜厚が０．０３～０．０５のときに、SiO_2膜の厚みと、オイラー角のθとが、下記の表２０に示すいずれかの組み合わせとなるように選択されれば、より一層良好な特性を得ることができる。この場合においても、下記の表２０の右側に示すより好ましいオイラー角を選択することにより、特性をより一層改善することができる。
【０１８７】
【表２０】

Ａｇ膜厚H／λ：０．０３～０．０５のとき

SiO_2膜厚	$LiTaO_3$のオイラー角	より好ましいオイラー角
０．１５～０．１８	０±３，１２２～１４２，０±３	０±３，１２３～１４０，０±３
０．１８～０．２３	０±３，１２０～１４０，０±３	０±３，１２２～１３７，０±３
０．２３～０．２８	０±３，１１７～１３８，０±３	０±３，１２０～１３５，０±３
０．２８～０．３３	０±３，１１６～１３６，０±３	０±３，１１８～１３４，０±３
０．３３～０．３８	０±３，１１４～１３５，０±３	０±３，１１７～１３３，０±３
０．３８～０．４０	０±３，１１３～１３０，０±３	０±３，１１５～１２８，０±３

【０１８８】
なお、本発明では、ＩＤＴはＡｇのみから構成されてもよいが、Ａｇを主体とする限り、Ａｇ合金やＡｇと他の金属との積層体で構成されてもよい。Ａｇを主体とするＩＤＴとは、ＩＤＴの全体の８０重量％以上がＡｇであればよい。従って、Ａｇの下地にＡｌ薄膜やＴｉ薄膜が形成されていてもよく、この場合においても、下地の薄膜とＡｇとの合計のう

ち８０重量％以上がＡｇで構成されていればよい。
【０１３９】
上記実験では、オイラー角（０°，θ，０°）の$LiTaO_3$基板が用いられたが、基板材料のオイラー角において、φ及びψには０±３°のばらつきが通常発生する。このようなばらつきの範囲内、すなわち（０±３°，１１３°～１４２°，０±３°）の$LiTaO_3$基板においても、本発明の効果は得られる。
【０１４０】
なお、オイラー角のθが所望の角度から－２°～＋４°ずれることがある。このずれは本願明細書における計算結果が基板の全面に金属膜を形成したものから計算されたものであるため、実際の弾性表面波装置では上記の範囲で誤差が発生することもある。
【０１４１】
〔Ｃｕを電極材料として用いた場合の実施例〕
Ｃｕにより電極を形成したことを除いては、Ａｕを用いた場合と同様に図１５に示した弾性表面波装置を構成した。Ａｌに比べて密度の高いＣｕにより電極が構成されているため、電気機械結合係数及び反射係数を高めることができる。
【０１４２】
図５８は、SiO_2膜の規格化膜厚が０．２０の場合のＣｕ電極とＡｌ電極の電極膜一本あたりの反射率と、電極膜厚との関係を示す図である。
図５８に示すように、従来用いられているＡｌからなる電極に比べて、Ｃｕからなる電極を用いた場合、電極指１本あたりの反射率が高められるため、反射器における電極指の本数も低減することができる。従って、反射器の小型化、ひいては弾性表面波装置の小型化を図ることができる。
【０１４３】
後述するように、ＩＤＴ２３ａ，２３ｂの弾性表面波の波長で規格化された膜厚Ｈ／λは０．０１～０．０８が好ましい。
図４８は、オイラー角（０°，１２０°，０°）の$LiTaO_3$基板上に規格化膜厚Ｈ／λが０．１０以下のＣｕからなる電極と、規格化膜厚ＨＳ／λが０～０．５のSiO_2膜を形成した場合における減衰定数αの変化を示す。図４８から明らかなように、SiO_2膜の膜厚ＨＳ／λが０．２～０．４０、Ｃｕ膜の膜厚Ｈ／λが０．０１～０．１０である場合に減衰定数αが小さくなっていることがわかる。
【０１４４】
他方、図４９は、（０°，１３５°，０°）のオイラー角の$LiTaO_3$基板上には、規格化膜厚Ｈ／λが０～０．１０のＣｕ膜を形成し、さらに、規格化膜厚ＨＳ／λが０～０．５のSiO_2膜を形成した場合の減衰定数αの変化を示す。
【０１４５】
図４９から明らかなように、θ＝１３５°の$LiTaO_3$基板を用いた場合には、Ｃｕ膜の膜厚及びSiO_2膜の膜厚を上記のように変化させたとしても、減衰定数αは大きいことがわかる。
【０１４６】
すなわち、良好なＴＣＦ、大きな電気機械結合係数及び小さな減衰定数を実現するには、$LiTaO_3$基板のカット角すなわちオイラー角と、SiO_2膜の膜厚と、Ｃｕからなる電極の膜厚とをそれぞれ最適なように組み合わせることが必要となることがわかる。
【０１４７】
図５０～図５７は、それぞれ、SiO_2膜の規格化膜厚ＨＳ／λが、０．１、０．１５、０．２、０．２５、０．３、０．３５、０．４または０．４５であり、規格化膜厚Ｈ／λが０．０８以下のＣｕ膜を$LiTaO_3$基板上に形成した場合のθと減衰定数αとの関係を示す。
【０１４８】
図５０～図５７から明らかなように、Ｃｕ膜の厚みＨ／λを０．０１～０．０８とした場合、SiO_2膜の厚みと、オイラー角のθとが、下記の表２１に示すように選択されれば

、周波数温度特性ＴＣＦが±２０ＰＰｍ／℃の範囲内とされて良好であり、電気機械結合係数が大きく、かつ減衰定数αを効果的に抑制し得ることがわかる。望ましくは、下記の表２１の右側のより好ましいオイラー角を選択することにより、より一層良好な特性を得ることができる。

【０１４９】

【表２１】

SiO_2膜厚	$LiTaO_3$のオイラー角	より好ましくは
０．１５～０．１８	(０±３，１１７～１３７，０±３)	(０±３，１２０～１３５，０±３)
０．１８～０．２３	(０±３，１１７～１３６，０±３)	(０±３，１１８～１３３，０±３)
０．２３～０．２８	(０±３，１１５～１３５，０±３)	(０±３，１１７～１３３，０±３)
０．２８～０．３３	(０±３，１１３～１３３，０±３)	(０±３，１１５～１３２，０±３)
０．３３～０．３８	(０±３，１１３～１３５，０±３)	(０±３，１１５～１３３，０±３)
０．３８～０．４	(０±３，１１３～１３２，０±３)	(０±３，１１５～１３０，０±３)

【０１５０】

また、Ａｕについての図２５から推測されるように、オイラー角のθが１２５°以下になると、電気機械結合係数K_{saw}が著しく大きくなることがわかる。従って、より好ましくは、下記の表２２に示すSiO_2膜の規格化膜厚ＨＳ／λとオイラー角との組み合わせが望ましいことがわかる。

【０１５１】

【表２２】

SiO_2膜厚	$LiTaO_3$のオイラー角
０．１５～０．１８	(０±３，１１７～１２５，０±３)
０．１８～０．２３	(０±３，１１７～１２５，０±３)
０．２３～０．２８	(０±３，１１５～１２５，０±３)
０．２８～０．３３	(０±３，１１３～１２５，０±３)
０．３３～０．３８	(０±３，１１３～１２５，０±３)
０．３８～０．４０	(０±３，１１３～１２５，０±３)

【０１５２】

さらに、図４８～図５６に示した結果から、減衰定数が０もしくは最小となるオイラー角、すなわちθ_{min}を、SiO_2膜の規格化膜厚ＨＳ／λ及びＣｕ膜の規格化膜厚Ｈ／λに対して求めた結果を、図５９に示す。

【０１５３】

Ｃｕ膜の規格化膜厚Ｈ／λが、０、０．０２、０．０４、０．０６及び０．０８の場合の図５９に示す各曲線を三次式で近似することにより、下記の式Ａ～Ｅが得られる。

(ａ）０＜Ｈ／λ≦０．０１のとき

$\theta_{min}=-139.718\times HS^3+43.07132\times HS^2-20.568011\times HS+125.8314$　式Ａ

(ｂ）０．０１＜Ｈ／λ≦０．０３のとき

$\theta_{min}=-139.660\times HS^3+46.02985\times HS^2-21.141500\times hS+127.4181$　式Ｂ（ｃ）０．０３＜Ｈ／λ≦０．０５のとき

$\theta_{min}=-139.607\times HS^3+48.98838\times HS^2-21.714900\times HS+129.0048$　式Ｃ（ｄ）０．０５＜Ｈ／λ≦０．０７のとき

$\theta_{min}=-112.068\times HS^3+39.60355\times HS^2-21.186000\times HS+129.9397$　式Ｄ（ｅ）０．０７＜Ｈ／λ≦０．０９のとき

$\theta_{min}=-126.954\times HS^3+67.40488\times HS^2-29.482000\times HS+131.5686$ 式E

従って、好ましくは、オイラー角（0±3°，θ，0±3°）のθは、上述した式A～式Eで示されるθ_{min}とされることが望ましいが、$\theta_{min}-2°<\theta\leqq\theta_{min}+2°$であれば、減衰定数を効果的に小さくすることができる。

【０１５４】

なお、本発明ではＩＤＴはＣｕのみから構成されてもよいが、Ｃｕを主体とする限り、Ｃｕ合金やＣｕと他の金属との積層体で構成されてもよい。Ｃｕを主体とするＩＤＴとは、電極の平均密度をρ（平均）とすると

ρ（Ｃｕ）×０．７≦ρ（平均）≦ρ（Ｃｕ）×１．３

すなわち、

$6.25 g/cm^3\leqq$ρ（平均）$\leqq 11.6 g/cm^3$

を満足するものであればよい。なお、Ｃｕの上あるいは下に電極全体のρ（平均）が上記範囲となるように、Ａｌよりも密度の大きいＷ、Ｔａ、Ａｕ、Ｐｔ、ＡｇまたはＣｒなどの金属からなる電極を積層してもよい。その場合にも、Ｃｕ電極単層の場合と同様の効果が得られる。

【０１５５】

なお、オイラー角のθが所望の角度から－２°～＋４°ずれることがある。このずれは本願明細書における計算結果が基板の全面に金属膜を形成したものから計算されたものであるため、実際の弾性表面波装置では上記の範囲で誤差が発生することもある。

【０１５６】

また、製造の際、オイラー角のφとψは０°から±３°ばらつくが、特性は０°のものとほぼ同じ特性が得られた。

〔電極材料としてタングステンを用いた実施例〕

前述した実施例と同様に、図１５に示した弾性表面波装置を構成した。但し、ＩＤＴ及び反射器をタングステンにより構成した。ＩＤＴの規格化膜厚Ｈ／λは０．００２５～０．０６の範囲とした。

【０１５７】

また、$LiTaO_3$基板としては、２２°～４８°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１１２°～１３８°，０°）の$LiTaO_3$基板を用いた。

本実施例では上記のように、２２°～４８°回転Ｙ板Ｘ伝搬$LiTaO_3$からなる圧電基板２２と、Ｈ／λ＝０．００２５～０．０６であるタングステンよりなるＩＤＴ３ａ，３ｂと、ＨＳ／λ＝０．１０～０．４０の範囲にあるSiO_2膜４とを用いているため、周波数温度係数ＴＣＦが小さく、電気機械結合係数K_{saw}が大きく、かつ伝搬損失が小さい弾性表面波装置を提供することができる。これを、以下の具体的な実験例に基づき説明する。

【０１５８】

図６０及び図６１は、オイラー角（０°，１２０°，０°）と、（０°，１４０°，０°）の各$LiTaO_3$基板上に、種々の膜厚のタングステンからなるＩＤＴと、種々の膜厚のSiO_2膜とを形成した場合の減衰定数を示す図である。

【０１５９】

図６０から明らかなように、θ＝１２０°では、SiO_2の膜厚ＨＳ／λが０．１～０．４０かつタングステンよりなる電極の規格化膜厚Ｈ／λが０．０～０．１０の範囲において、減衰定数が小さいことがわかる。他方、図６１から明らかなように、θ＝１４０°では、タングステンからなる電極の規格化膜厚Ｈ／λが０．０～０．１０の範囲では、SiO_2膜の膜厚の如何に係わらず、減衰定数が大きくなっていることがわかる。

【０１６０】

すなわち、ＴＣＦを±２０ＰＰｍ／℃と小さくし、大きな電気機械結合係数を得、かつ減衰定数を小さくするには、$LiTaO_3$基板のオイラー角、SiO_2膜の厚み及びタングステンからなる電極の膜厚の３つの条件を考慮しなければならないことがわかる。

【０１６１】
図６２～図６５は、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λ及びタングステンからなる電極膜の規格化膜厚Ｈ／λを変化させた場合の、θ（度）と減衰定数との関係を示す。
【０１６２】
図６２～図６５から明らかなように、タングステンからなる電極の規格化膜厚Ｈ／λが０．０１２～０．０５３及び０．０１５～０．０４２において、ＳｉＯ$_2$膜の膜厚と、最適なθとの関係は、下記の表２３及び表２４に示す通りとなる。なお、この最適θは、タングステン電極の電極指幅のばらつきや単結晶基板のばらつきにより－２°～＋４°程度ばらつくことがある。なお、図中、図示していない膜厚は比例配分による。
【０１６３】
【表２３】

電極のH/λ＝0.012～0.053のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角	より好ましくは
0.1～0.15	(0±3,114.2～138,0±3)	(0±3,117.7～134,0±3)
0.15～0.2	(0±3,113～137.8,0±3)	(0±3,117～133.5,0±3)
0.2～0.3	(0±3,113～137.5,0±3)	(0±3,116.5～133,0±3)
0.3～0.35	(0±3,112.7～137,0±3)	(0±3,116.5～133,0±3)
0.35～0.4	(0±3,112.5～136,0±3)	(0±3,116.5～132.3,0±3)

【０１６４】
【表２４】

電極のH/λ＝0.015～0.042のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角	より好ましくは
0.1～0.15	(0±3,114.3～138,0±3)	(0±3,117.7～133.5,0±3)
0.15～0.2	(0±3,113～137.5,0±3)	(0±3,117.7～133.5,0±3)
0.2～0.3	(0±3,112.5～137,0±3)	(0±3,117～132.5,0±3)
0.3～0.35	(0±3,112.2～136.5,0±3)	(0±3,116.8～132.5,0±3)
0.35～0.4	(0±3,112～135.3,0±3)	(0±3,116～131.5,0±3)

【０１６５】
すなわち、表２３及び表２４から明らかなように、タングステンよりなる電極の膜厚Ｈ／λが、０．０１２～０．０５３の場合、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内となるように改善するために、ＳｉＯ$_2$膜の膜厚ＨＳ／λを０．１～０．４の範囲とした場合、ＬｉＴａＯ$_3$のオイラー角におけるθは、１１２°～１３８°の範囲、すなわち、回転角で２０°～５０°の範囲、より好ましくは、表２３に示すオイラー角を選択すればよいことがわかる。
【０１６６】
同様に、表２４から明らかなように、タングステン膜からなる電極の規格化膜厚が０．０１５～０．０４２であり、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内となるように改善するために、ＳｉＯ$_2$膜の膜厚ＨＳ／λを０．１～０．４の範囲とした場合には、ＬｉＴａＯ$_3$基板のオイラー角は１１２°～１３８°の範囲とすればよく、より好ましくはＳｉＯ$_2$膜の膜厚に応じて表２４のオイラー角を選択すればよいことがわかる。
【０１６７】
ここで、表２３及び表２４における「ＬｉＴａＯ$_3$のオイラー角」の範囲は、減衰定数が０．０５以下の範囲を規定したものである。また、表２３及び表２４におけるＬｉＴａＯ$_3$のオイラー角の「より好ましい」範囲は、減衰定数が０．０２５以下に規定したものである。また、タングステンからなる電極膜の規格化膜厚が０．０１２、０．０１５、０．０４２、０．０５３である場合のＳｉＯ$_2$膜の膜厚ＨＳ／λとオイラー角の関係は、図６２～図６５に示すタングステンからなる電極膜の規格化膜厚から換算して求めたものであ

り、それによって、表２３及び表２４のSiO_2膜の膜厚とオイラー角の値を求めている。

【０１６８】

本発明に係る弾性表面波装置の製造に際しては、回転Ｙ板Ｘ伝搬$LiTaO_3$基板上にタングステンを主成分とする金属からなるＩＤＴを形成した後、その状態において周波数調整を行い、しかる後減衰定数αを小さくし得る範囲の膜厚のSiO_2膜を成膜することが望ましい。これを、図６６及び図６７を参照して説明する。図６６は、オイラー角（０°，１２６°，０°）の回転Ｙ板Ｘ伝搬$LiTaO_3$基板上に、種々の厚みＨ／λのタングステンからなるＩＤＴ及び種々の膜厚ＨＳ／λのSiO_2膜を形成した場合の漏洩弾性表面波の音速の変化を示す。また、図６７は、同じオイラー角の$LiTaO_3$基板上に、種々の膜厚Ｈ／λのタングステンからなるＩＤＴを形成した場合、その上に形成されるSiO_2膜の規格化膜厚ＨＳ／λを変化させた場合の漏洩弾性表面波の音速の変化を示す。図６６と図６７を比較すれば明らかなように、タングステンの膜厚を変化させた場合の方が、SiO_2膜の膜厚を変化させた場合よりも弾性表面波の音速の変化がはるかに大きい。従って、SiO_2膜の形成に先立ち、周波数調整が、行われることが望ましく、例えば、レーザーエッチングやイオンエッチングなどによりタングステン（Ｗ）からなるＩＤＴを形成した後に周波数調整を行うことが望ましい。

【０１６９】

なお、本発明は、上記のように、２２°～４８°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１１２°～１３８°，０°）の$LiTaO_3$からなる圧電基板、Ｈ／λ＝０．００２５～０．０６であるタングステンよりなるＩＤＴと、ＨＳ／λ＝０．１０～０．４０であるSiO_2膜とを有することを特徴とするものであり、従って、ＩＤＴの数及び構造等については特に限定されない。すなわち、本発明は、図１５に示した弾性表面波装置だけでなく、上記条件を満たす限り、様々な弾性表面波共振子や弾性表面波フィルタ等に適用することができる。

【０１７０】

なお、オイラー角のθが所望の角度から－２°～＋４°ずれることがある。このずれは本願明細書における計算結果が基板の全面に金属膜を形成したものから計算されたものであるため、実際の弾性表面波装置では上記の範囲で誤差が発生することもある。

また、製造の際、オイラー角のφとψは０°から±３°ばらつくが、特性は０°のものとほぼ同じ特性が得られた。

【０１７１】

〔電極材料としてＴａを用いた場合の実施例〕

図１５に示した弾性表面波装置を構成した。但し、１４°～５８°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１０４°～１４８°，０°）の$LiTaO_3$からなる基板を圧電性基板２２として用い、かつＩＤＴはタンタル（Ｔａ）により構成し、その規格化膜厚Ｈ／λは０．００４～０．０５５の範囲とした。

【０１７２】

本実施例では上記のように、１４°～５８°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１０４°～１４８°，０°）の$LiTaO_3$からなる圧電基板２と、Ｈ／λ＝０．００４～０．０５５であるタンタルよりなるＩＤＴ３ａ，３ｂと、ＨＳ／λ＝０．１０～０．４０の範囲にあるSiO_2膜４とを用いているため、周波数温度係数ＴＣＦが小さく、電気機械結合係数K_{saw}が大きく、かつ伝搬損失が小さい弾性表面波装置を提供することができる。これを、以下の具体的な実験例に基づき説明する。

【０１７３】

図６８及び図６９は、オイラー角（０°，１２０°，０°）と、（０°，１４０°，０°）の各$LiTaO_3$基板上に、種々の膜厚のタンタルからなるＩＤＴと、種々の膜厚のSiO_2膜とを形成した場合の減衰定数を示す図である。

【０１７４】

図６８から明らかなように、θ＝１２０°では、SiO_2の膜厚ＨＳ／λが０．１～０．

４０かつタンタルよりなる電極の規格化膜厚Ｈ／λが０．０～０．１０の範囲において、減衰定数が小さいことがわかる。他方、図６９から明らかなように、θ＝１４０°では、タンタルからなる電極の規格化膜厚Ｈ／λが０．０～０．０６の範囲では、SiO_2膜の膜厚の如何に係わらず、減衰定数が大きくなっていることがわかる。

【０１７５】

すなわち、ＴＣＦの絶対値を小さくし、大きな電気機械結合係数を得、かつ減衰定数を小さくするには、$LiTaO_3$基板のオイラー角、SiO_2膜の厚み及びタンタルからなる電極の膜厚の３つの条件を考慮しなければならないことがわかる。

【０１７６】

図７０～図７３は、SiO_2膜の規格化膜厚ＨＳ／λ及びタンタルからなる電極膜の規格化膜厚Ｈ／λを変化させた場合の、θと減衰定数との関係を示す。

図７０～図７３から明らかなように、タンタルからなる電極の規格化膜厚Ｈ／λが０．０１～０．０５５及び０．０１６～０．０４５において、SiO_2膜の膜厚と、最適なθとの関係は、下記の表２５及び表２６に示す通りとなる。なお、この最適θは、タンタル電極の電極指幅のばらつきや単結晶基板のばらつきにより－２°～＋４°程度ばらつくことがある。

【０１７７】

【表２５】

電極のH/λ＝0.01～0.055のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角	より好ましくは
0.1～0.15	(0±3,110.5～148,0±3)	(0±3,116～143,0±3)
0.15～0.2	(0±3,108～147.5,0±3)	(0±3,115～141.5,0±3)
0.2～0.3	(0±3,105～148,0±3)	(0±3,111～139,0±3)
0.3～0.35	(0±3,104.5～148,0±3)	(0±3,111～139,0±3)
0.35～0.4	(0±3,104～145,0±3)	(0±3,110～138.5,0±3)

【０１７８】

【表２６】

電極のH/λ＝0.016～0.045のとき

SiO_2の規格化膜厚	$LiTaO_3$のｵｲﾗｰ角	より好ましくは
0.1～0.15	(0±3,113～144,0±3)	(0±3,118～140,0±3)
0.15～0.2	(0±3,111～144,0±3)	(0±3,117～139.5,0±3)
0.2～0.3	(0±3,108～144,0±3)	(0±3,113～139,0±3)
0.3～0.35	(0±3,107.5～143,0±3)	(0±3,112.5～137,0±3)
0.35～0.4	(0±3,107～140.5,0±3)	(0±3,112～135.5,0±3)

【０１７９】

すなわち、表２５及び表２６から明らかなように、タンタルよりなる電極の膜厚Ｈ／λが、０．０１～０．０５５の場合、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内とするように改善するために、SiO_2膜の規格化膜厚を０．１～０．４の範囲とした場合、$LiTaO_3$のオイラー角におけるθは、１０４°～１４８°の範囲、すなわち、回転角で１４°～５８°の範囲、より好ましくは、SiO_2の膜厚ＨＳ／λに応じて表２５に示すオイラー角を選択すればよいことがわかる。

【０１８０】

同様に、表２６から明らかなように、タンタル膜からなる電極の規格化膜厚が０．０１６～０．０４５であり、周波数温度特性ＴＣＦを改善するために、SiO_2膜の膜厚ＨＳ／

λを０．１～０．４の範囲とした場合には、ＬｉＴａＯ$_3$基板のオイラー角は１０７°～１４４°の範囲とすればよく、より好ましくはＳｉＯ$_2$膜の膜厚ＨＳ／λに応じて表２６のオイラー角を選択すればよいことがわかる。

【０１８１】

ＬｉＴａＯ$_3$のオイラー角の範囲は、減衰定数が０．０５以下の範囲を規定したものである。また、表２５及び表２６におけるＬｉＴａＯ$_3$のオイラー角のより好ましい範囲は、減衰定数が０．０２５以下に規定したものである。また、タンタルからなる電極膜の規格化膜厚が０．０１２、０．０１５、０．０４２、０．０５３である場合のＳｉＯ$_2$膜の膜厚ＨＳ／λとオイラー角の関係は、図７０～図７３に示すタンタルからなる電極膜の規格化膜厚から換算して求めて、表２５及び表２６のＳｉＯ$_2$膜の膜厚ＨＳ／λとオイラー角の値を求めている。

【０１８２】

本発明に係る弾性表面波装置の製造に際しては、回転Ｙ板Ｘ伝搬ＬｉＴａＯ$_3$基板上にタンタルを主成分とする金属からなるＩＤＴを形成した後、その状態において周波数調整を行い、しかる後減衰定数αを小さくし得る範囲の膜厚のＳｉＯ$_2$膜を成膜することが望ましい。これを、図７４及び図７５を参照して説明する。図７４は、オイラー角（０°，１２６°，０°）の回転Ｙ板Ｘ伝搬ＬｉＴａＯ$_3$基板上に、タンタルからなるＩＤＴ及びＳｉＯ$_2$膜を形成した場合の、タンタルの規格化膜厚Ｈ／λと、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λと、漏洩弾性表面波の音速との関係を示す。また、図７５は、同じオイラー角のＬｉＴａＯ$_3$基板上に、種々の膜厚のタンタルからなるＩＤＴを形成し、その上に形成されるＳｉＯ$_2$膜の規格化膜厚を変化させた場合の漏洩弾性表面波の音速の変化を示す。図７４と図７５を比較すれば明らかなように、タンタルの膜厚を変化させた場合の方が、ＳｉＯ$_2$膜の膜厚を変化させた場合よりも弾性表面波の音速の変化がはるかに大きい。従って、ＳｉＯ$_2$膜の形成に先立ち、周波数調整が、行われることが望ましく、例えば、レーザーエッチングやイオンエッチングなどによりタンタルからなるＩＤＴを形成した後に周波数調整を行うことが望ましい。

【０１８３】

なお、本発明は、上記のように、１４°～５８°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１０４°～１４８°，０°）のＬｉＴａＯ$_3$からなる圧電基板、Ｈ／λ＝０．００４～０．０５５であるタンタルよりなるＩＤＴと、ＨＳ／λ＝０．１０～０．４０であるＳｉＯ$_2$膜とを有することを特徴とするものであり、従って、ＩＤＴの数及び構造等については特に限定されない。すなわち、本発明は、図１５に示した弾性表面波装置だけでなく、上記条件を満たす限り、様々な弾性表面波共振子や弾性表面波フィルタ等に適用することができる。

【０１８４】

なお、オイラー角のθが所望の角度から－２°～＋４°ずれることがある。このずれは本願明細書における計算結果が基板の全面に金属膜を形成したものから計算されたものであるため、実際の弾性表面波装置では上記の範囲で誤差が発生することもある。

また、製造の際、オイラー角のφとψは０°から±３°ばらつくが、特性は０°のものとほぼ同じ特性が得られた。

【０１８５】

〔電極材料として白金を用いた実施例〕

図１５に示した弾性表面波装置を、０°～７９°回転Ｙ板Ｘ伝搬、オイラー角で（０°，９０°～１６９°，０°）のＬｉＴａＯ$_3$基板からなる圧電基板と、Ｈ／λ＝０．００５～０．０５４である白金よりなるＩＤＴを用いて構成した。その他の点は前述した実施例と同様である。

【０１８６】

本実施例においても、上記構成を備えるため、周波数温度係数ＴＣＦが小さく、電気機械結合係数K_{saw}が大きく、かつ伝搬損失が小さい弾性表面波装置を提供することができる。これを、以下の具体的な実験例に基づき説明する。

【０１８７】
図７６及び図７７は、オイラー角（０°，１２５°，０°）と、（０°，１４０°，０°）の各ＬｉＴａＯ$_3$基板上に、種々の膜厚の白金からなるＩＤＴと、種々の膜厚のＳｉＯ$_2$膜とを形成した場合の減衰定数を示す図である。
【０１８８】
図７６から明らかなように、θ＝１２５°では、ＳｉＯ$_2$の膜厚ＨＳ／λが０．１～０．４０かつ白金よりなる電極の規格化膜厚Ｈ／λが０．００５～０．０６の範囲において、減衰定数が小さいことがわかる。他方、図７７から明らかなように、θ＝１４０°では、白金からなる電極の規格化膜厚Ｈ／λが０．００５～０．０６の範囲では、ＳｉＯ$_2$膜の膜厚ＨＳ／λの如何に係わらず、減衰定数が大きくなっていることがわかる。
【０１８９】
すなわち、ＴＣＦの絶対値を小さくし、大きな電気機械結合係数を得、かつ減衰定数を小さくするには、ＬｉＴａＯ$_3$基板のオイラー角、ＳｉＯ$_2$膜の厚み及び白金からなる電極の膜厚の３つの条件を考慮しなければならないことがわかる。
【０１９０】
図７８～図８３は、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λ及び白金からなる電極膜の規格化膜厚Ｈ／λを変化させた場合の、オイラー角のθ（度）と減衰定数との関係を示す。
【０１９１】
図７８～図８３から明らかなように、白金からなる電極の規格化膜厚Ｈ／λが０．００５～０．０５４では、θは９０°～１６９°の範囲とすることが望ましいことがわかる。また、白金からなる電極の規格化膜厚Ｈ／λが０．０１～０．０４及び０．０１３～０．０３３においては、ＳｉＯ$_2$膜の膜厚ＨＳ／λと、最適なθとの関係は、減衰定数αを低下させることも考慮すると、下記の表２７及び表２８に示す通りとなる。ここで、表２７及び表２８における「ＬｉＴａＯ$_3$のオイラー角」の範囲は、減衰定数が０．０５ｄＢ／λ以下の範囲を規定したものである。また、表２７及び表２８におけるＬｉＴａＯ$_3$のオイラー角の「より好ましい」範囲は、減衰定数が０．０２５ｄＢ／λ以下の範囲を規定したものである。なお、この最適θは、白金電極の電極指幅のばらつきや単結晶基板のばらつきにより－２°～＋４°程度ばらつくことがある。
【０１９２】
また、製造の際、オイラー角のφとψは０°から±３°ばらつくが、特性は０°のものとほぼ同じ特性が得られた。
【０１９３】
【表２７】
白金H/λ＝0.01～0.04のとき

SiO_2厚(Hs/λ)	オイラー角	より好ましいオイラー角
0.1 ≦ Hs/λ＜0.15	(0±3°,90°～169°,0±3°)	(0±3°,105°～153°,0±3°)
0.15≦ Hs/λ＜0.2	(0±3°,90°～167°,0±3°)	(0±3°,105°～152°,0±3°)
0.20≦ Hs/λ＜0.25	(0±3°,90°～167°,0±3°)	(0±3°,107°～152°,0±3°)
0.25≦ Hs/λ＜0.3	(0±3°,90°～164°,0±3°)	(0±3°,104°～151°,0±3°)
0.3 ≦ Hs/λ＜0.4	(0±3°,90°～163°,0±3°)	(0±3°,105°～150°,0±3°)

【０１９４】
【表２８】

白金H/λ＝0.013～0.033のとき

SiO_2厚(Hs/λ)	オイラー角	より好ましいオイラー角
0.1 ≦ Hs/λ＜0.15	(0±3°,106°～155°,0±3°)	(0±3°,116°～147.5°,0±3°)
0.15≦ Hs/λ＜0.2	(0±3°,104°～155°,0±3°)	(0±3°,113.5°～150°,0±3°)
0.20≦ Hs/λ＜0.25	(0±3°,102°～155°,0±3°)	(0±3°,111.5°～150°,0±3°)
0.25≦ Hs/λ＜0.3	(0±3°,102°～154°,0±3°)	(0±3°,112°～146°,0±3°)
0.3 ≦ Hs/λ＜0.4	(0±3°,102°～153°,0±3°)	(0±3°,110°～144.5°,0±3°)

【０１９５】
すなわち、表２７及び表２８から明らかなように、白金よりなる電極の膜厚Ｈ／λが、０．０１～０．０４の場合、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内となるように改善するために、SiO_2膜の膜厚ＨＳ／λを０．１～０．４の範囲とした場合、$LiTaO_3$のオイラー角におけるθは、９０°～１６９°の範囲、すなわち、回転角で０°～７９°の範囲を選択すればよいことがわかる。
【０１９６】
同様に、表２７から明らかなように、白金膜からなる電極の規格化膜厚が０．０１～０．０４であり、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内となるように改善するために、SiO_2膜の膜厚ＨＳ／λを０．１～０．４の範囲とした場合には、$LiTaO_3$基板のオイラー角のθは９０°～１６９°の範囲とすればよく、より好ましくはSiO_2膜の膜厚に応じて表２７のオイラー角を選択すればよいことがわかる。
【０１９７】
同様に、白金膜からなる電極の規格化膜厚が０．０１３～０．０３３であり、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲となるように改善するために、SiO_2膜の膜厚ＨＳ／λを０．１～０．４の範囲とした場合には、$LiTaO_3$基板のオイラー角のθは、１０２°～１５０°の範囲とすればよく、より好ましくは、SiO_2膜の膜厚ＨＳ／λに応じて表２８のオイラー角を選択すればよいことがわかる。
【０１９８】
また、白金からなる電極膜の規格化膜厚が０．０１３～０．０３３である場合のSiO_2膜の膜厚とオイラー角の関係は、図７８～図８３に示す白金からなる電極膜の規格化膜厚から換算して求めたものであり、それによって、表２７及び表２８のSiO_2膜の膜厚ＨＳ／λとオイラー角の値を求めている。
【０１９９】
本発明に係る弾性表面波装置の製造に際しては、回転Ｙ板Ｘ伝搬$LiTaO_3$基板上に白金を主成分とする金属からなるＩＤＴを形成した後、その状態において周波数調整を行い、しかる後減衰定数αを小さくし得る範囲の膜厚ＨＳ／λのSiO_2膜を成膜することが望ましい。これを、図８４及び図８５を参照して説明する。図８４は、オイラー角（０°，１２６°，０°）の回転Ｙ板Ｘ伝搬$LiTaO_3$基板上に、種々の厚みＨ／λの白金からなるＩＤＴ及び種々の膜厚ＨＳ／λのSiO_2膜を形成した場合の漏洩弾性表面波の音速の変化を示す。また、図８５は、同じオイラー角の$LiTaO_3$基板上に、種々の膜厚Ｈ／λの白金からなるＩＤＴを形成した場合、その上に形成されるSiO_2膜の規格化膜厚ＨＳ／λを変化させた場合の漏洩弾性表面波の音速の変化を示す。図８４と図８５を比較すれば明らかなように、白金の膜厚を変化させた場合の方が、SiO_2膜の膜厚を変化させた場合よりも弾性表面波の音速の変化がはるかに大きい。従って、SiO_2膜の形成に先立ち、周波数調整が、行われることが望ましく、例えば、レーザーエッチングやイオンエッチングなどにより白金からなるＩＤＴを形成した後に周波数調整を行うことが望ましい。
【０２００】
なお、本発明は、上記のように、０°～７９°回転Ｙ板Ｘ伝搬、オイラー角で（０°，９０°～１６９°，０°）の$LiTaO_3$からなる圧電基板、Ｈ／λ＝０．００５～０．０５４である白金よりなるＩＤＴと、ＨＳ／λ＝０．１０～０．４０であるSiO_2膜とを

有することを特徴とするものであり、従って、ＩＤＴの数及び構造等については特に限定されない。すなわち、本発明は、図１に示した弾性表面波装置だけでなく、上記条件を満たす限り、様々な弾性表面波共振子や弾性表面波フィルタ等に適用することができる。

【０２０１】

〔ニッケル及びモリブデンを電極材料として用いた実施例〕

図１５に示した弾性表面波装置を構成した。電極材料としてニッケルまたはモリブデンを用いた。また、圧電性基板として、１４°～５０°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１０４°～１４０°，０°）の$LiTaO_3$基板を用いた。その他の点は同様である。

【０２０２】

ＩＤＴ２３ａ，２３ｂ及び反射器２５ａ，２５ｂは、密度が８７００～１０３００ｋｇ／m^3、ヤング率が1.8×10^{11}～4×10^{11}Ｎ／m^2及び横波音速が３１７０～３２９０ｍ／秒である金属により構成されている。このような金属としては、ニッケルやモリブデンまたはこれらを主体とする合金が挙げられる。

【０２０３】

ＩＤＴ２３ａ，２３ｂの規格化膜厚Ｈ／λ（ＨはＩＤＴの厚み、λは中心周波数における波長を示す）は０．００８～０．０６の範囲とされている。

本実施例では上記のように、１４°～５０°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１０４°～１４０°，０°）の$LiTaO_3$からなる圧電基板２２と、Ｈ／λ＝０．００８～０．０６であり、上記特定の金属よりなるＩＤＴ２３ａ，２３ｂと、ＨＳ／λ＝０．１０～０．４０の範囲にあるSiO_2膜２４とを用いているため、周波数温度係数ＴＣＦが±２０ＰＰｍ／℃の範囲内となるように小さくされており、電気機械結合係数K_{saw}が大きく、かつ伝搬損失が小さい弾性表面波装置を提供することができる。これを、以下の具体的な実験例に基づき説明する。

【０２０４】

図８６及び図８７は、オイラー角（０°，１２０°，０°）と、（０°，１４０°，０°）の各$LiTaO_3$基板上に、種々の膜厚のＮｉからなるＩＤＴと、種々の膜厚ＨＳ／λのSiO_2膜とを形成した場合の減衰定数を示す図である。

【０２０５】

図８６から明らかなように、θ＝１２０°では、SiO_2の膜厚ＨＳ／λが０．１～０．４０かつＮｉよりなる電極の規格化膜厚Ｈ／λが０．００８～０．０８の範囲において、減衰定数が小さいことがわかる。他方、図８７から明らかなように、θ＝１４０°では、Ｎｉからなる電極の規格化膜厚Ｈ／λが０．００８～０．０８の範囲では、SiO_2膜の膜厚の如何に係わらず、減衰定数が大きくなっていることがわかる。

【０２０６】

図８８及び図８９は、オイラー角（０°，１２０°，０°）と（０°，１４０°，０°）の各$LiTaO_3$基板上に、種々の膜厚のＭｏからなるＩＤＴと、種々の膜厚ＨＳ／λのSiO_2膜とを形成した場合の減衰定数の変化を示す図である。

【０２０７】

図８８から明らかなように、θ＝１２０°では、SiO_2の膜厚ＨＳ／λが０．１～０．４０かつＭｏよりなる電極の規格化膜厚Ｈ／λが０．００８～０．０８の範囲において、減衰定数が小さいことがわかる。他方、図８９から明らかなように、θ＝１４０°では、Ｍｏからなる電極の規格化膜厚Ｈ／λが０．００８～０．０８の範囲では、SiO_2膜の膜厚ＨＳ／λの如何に係わらず、減衰定数が大きくなっていることがわかる。

【０２０８】

すなわち、ＴＣＦの絶対値を小さくし、大きな電気機械結合係数を得、かつ減衰定数を小さくするには、$LiTaO_3$基板のオイラー角、SiO_2膜の厚みＨＳ／λ及び上記特定の密度、ヤング率及び横波音速範囲の金属からなる電極の膜厚の３つの条件を考慮しなければならないことがわかる。

【０２０９】

図９０～図９３は、SiO_2膜の規格化膜厚ＨＳ／λ及びＮｉからなる電極膜の規格化膜

厚Ｈ／λを変化させた場合の、θ（度）と減衰定数との関係を示す。
図９４～図９７は、ＳｉＯ$_2$膜の規格化膜厚ＨＳ／λ及びＭｏからなる電極膜の規格化膜厚Ｈ／λを変化させた場合の、θ（度）と減衰定数との関係を示す。

【０２１０】
図９０～図９７から明らかなように、ＮｉまたはＭｏからなる電極の規格化膜厚Ｈ／λが０．００８～０．０６、０．０１７～０．０６及び０．０２３～０．０６において、ＳｉＯ$_2$膜の膜厚と、最適なθとの関係は、下記の表２９に示す通りとなる。なお、この最適θは、電極の電極指幅のばらつきや単結晶基板のばらつきにより－２°～＋４°程度ばらつくことがある。

【０２１１】
また、製造の際、オイラー角のφとψは０°から±３°ばらつくが、特性は０°のものとほぼ同じ特性が得られた。

【０２１２】
【表２９】

SiO_2	オイラー角	より好ましいオイラー角
0.1～0.2	(0±3°,105°～140°,0±3°)	(0±3°,110°～135°,0±3°)
0.2～0.3	(0±3°,105°～140°,0±3°)	(0±3°,108°～135°,0±3°)
0.3～0.4	(0±3°,104°～139°,0±3°)	(0±3°,108°～133°,0±3°)

【０２１３】
また、図９０～図９３で示したＮｉからなる電極の最適膜厚Ｈ／λ＝０．００８～０．０６、０．０２～０．０６及び０．０２７～０．０６におけるＳｉＯ$_2$膜の膜厚と最適なθとの関係は下記の表３０に示す通りとなる。

【０２１４】
【表３０】

SiO_2	オイラー角	より好ましいオイラー角
0.1～0.2	(0±3°,106°～140°,0±3°)	(0±3°,110°～135°,0±3°)
0.2～0.3	(0±3°,105°～137°,0±3°)	(0±3°,108°～134°,0±3°)
0.3～0.4	(0±3°,104°～133°,0±3°)	(0±3°,108°～132°,0±3°)

【０２１５】
また、図９４～図９７に示したＭｏからなる電極の最適膜厚Ｈ／λ＝０．００８～０．０６、０．０１７～０．０６及び０．０２３～０．０６におけるＳｉＯ$_2$膜の膜厚と、最適なθとの関係は下記の表３１に示す通りとなる。

【０２１６】
【表３１】

SiO_2	オイラー角	より好ましいオイラー角
0.1～0.2	(0±3°,107°～141°,0±3°)	(0±3°,110°～135°,0±3°)
0.2～0.3	(0±3°,104°～141°,0±3°)	(0±3°,109°～135°,0±3°)
0.3～0.4	(0±3°,104°～138°,0±3°)	(0±3°,108°～133°,0±3°)

【０２１７】
すなわち、表２９から明らかなように、上記特定の密度、ヤング率及び横波音速範囲の金属からなる電極の膜厚Ｈ／λが、０．００８～０．０６、０．０１７～０．０６及び０．０２３～０．０６で、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内となるように改善するために、ＳｉＯ$_2$膜の膜厚を０．１～０．４の範囲とした場合、ＬｉＴａＯ$_3$のオイラー角におけるθは、１０４°～１４０°の範囲、すなわち、回転角で１４°～５０°

の範囲、より好ましくは、表２９に示すオイラー角を選択すればよいことがわかる。
【０２１８】
同様に、Ｎｉ膜からなる電極の規格化膜厚Ｈ／λが０．００８～０．０６、０．０２～０．０６及び０．０２７～０．０６の場合において、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内となるように改善するために、ＨＳ／λが０．１～０．４のSiO_2膜の膜厚ＨＳ／λに応じて、$LiTaO_3$基板のオイラー角におけるθは１０４°～１４０°の範囲とすればよく、より好ましくはSiO_2膜の膜厚ＨＳ／λに応じて表３０に示したオイラー角を選択すればよいことがわかる。
【０２１９】
同様に、Ｍｏ膜からなる電極の規格化膜厚Ｈ／λが０．００８～０．０６、０．０２～０．０６及び０．０２７～０．０６の場合において、周波数温度特性ＴＣＦを±２０ＰＰｍ／℃の範囲内となるように改善するために、ＨＳ／λが０．１～０．４のSiO_2膜の膜厚ＨＳ／λに応じて、$LiTaO_3$基板のオイラー角におけるθは１０４°～１４１°の範囲とすればよく、より好ましくはSiO_2膜の膜厚ＨＳ／λに応じて表３１に示したオイラー角を選択すればよいことがわかる。
【０２２０】
ここで、表２９～表３１における「$LiTaO_3$のオイラー角」の範囲は、減衰定数αが０．１ｄＢ／λ以下の範囲を規定したものである。また、表２９～表３１における$LiTaO_3$のオイラー角の「より好ましい」範囲は、減衰定数が０．０５ｄＢ／λ以下の範囲を規定したものである。また、上記電極膜の規格化膜厚が０．０９５、０．０１７、０．０２３である場合のSiO_2膜の膜厚ＨＳ／λとオイラー角の関係は、図９０～図９７に示すＮｉもしくはＭｏからなる電極膜の規格化膜厚から換算して求めたものであり、それによって、表２９～表３１のSiO_2膜の膜厚とオイラー角の値を求めている。
【０２２１】
本発明に係る弾性表面波装置の製造に際しては、回転Ｙ板Ｘ伝搬$LiTaO_3$基板上にＮｉやＭｏなどの上記特定の金属からなるＩＤＴを形成した後、その状態において周波数調整を行い、しかる後減衰定数αを小さくし得る範囲の膜厚のSiO_2膜を成膜することが望ましい。これを、図９８～図１０１を参照して説明する。図９８及び図１００は、オイラー角（０°，１２６°，０°）の回転Ｙ板Ｘ伝搬$LiTaO_3$基板上に、種々の厚みＨ／λのＮｉまたはＭｏからなるＩＤＴ及び種々の膜厚ＨＳ／λのSiO_2膜を形成した場合の漏洩弾性表面波の音速の変化を示す。また、図９９及び図１０１は、同じオイラー角の$LiTaO_3$基板上に、種々の膜厚Ｈ／λのＮｉまたはＭｏからなるＩＤＴを形成した場合、その上に形成されるSiO_2膜の規格化膜厚ＨＳ／λを変化させた場合の漏洩弾性表面波の音速の変化を示す。図９８と図９９、及び図１００と図１０１とを比較すれば明らかなように、電極の膜厚を変化させた場合の方が、SiO_2膜の膜厚を変化させた場合よりも弾性表面波の音速の変化がはるかに大きい。従って、SiO_2膜の形成に先立ち、周波数調整が、行われることが望ましく、例えば、レーザーエッチングやイオンエッチングなどによりＮｉやＭｏからなるＩＤＴを形成した後に周波数調整を行うことが望ましい。
【０２２２】
なお、本発明は、上記のように、１４°～５０°回転Ｙ板Ｘ伝搬、オイラー角で（０°，１０４°～１４０°，０°）の$LiTaO_3$からなる圧電基板、Ｈ／λ＝０．００８～０．０６であるＮｉやＭｏなどの上記特定の密度、ヤング率及び横波音速範囲の金属よりなるＩＤＴと、ＨＳ／λ＝０．１０～０．４０であるSiO_2膜とを有することを特徴とするものであり、従って、ＩＤＴの数及び構造等については特に限定されない。すなわち、本発明は、図１５に示した弾性表面波装置だけでなく、上記条件を満たす限り、様々な弾性表面波共振子や弾性表面波フィルタ等に適用することができる。
【０２２３】
【発明の効果】
第１の発明に係る弾性表面波装置では、ＩＤＴ電極が形成されている領域を除いた残りの

領域において、ＩＤＴ電極と略等しい膜厚に形成された第１の絶縁物層が設けられており、ＩＤＴ電極及び第１絶縁物層を被覆するように第２絶縁物層が設けられている構成において、ＩＤＴ電極が第１絶縁物層の密度よりも高密度の金属または該金属を主成分とする合金からなるため、ＩＤＴ電極の反射係数を十分な大きさとすることができる。従って、所望でないリップルによる特性の劣化が生じ難い、周波数温度特性の良好な弾性表面波装置を提供することができる。

【０２２４】
加えて、ＩＤＴ電極と第１絶縁物層が略等しい膜厚とされており、ＩＤＴ電極及び第１絶縁物層を被覆するように第２絶縁物層が積層されているため、第２絶縁物層の外表面を平坦化することができ、それによって第２絶縁物層表面の凹凸による特性の劣化も生じ難い。

【０２２５】
第２の発明に係る弾性表面波装置では、ＩＤＴ電極が形成されている領域を除いた残りの領域にＩＤＴ電極とほぼ等しい膜厚の第１絶縁物層が設けられており、ＩＤＴ電極上に、ＩＤＴ電極を構成する金属もしくは合金よりも耐腐食性に優れた金属もしくは合金からなる保護金属膜が設けられており、保護金属膜及び第１絶縁物層上を被覆するように第２絶縁物層が形成されている。従って、ＩＤＴ電極が保護金属層及び第１絶縁物層により覆われているため、フォトリソグラフィー技術によりレジストを剥離する際のレジスト剥離液によるＩＤＴ電極の腐食が生じ難い。よって、Ｃｕなどのレジスト剥離液により腐食され易いが、密度がＡｌに比べて十分大きな金属もしくは合金を用いて、ＩＤＴ電極を構成することができ、弾性表面波装置の特性の劣化を効果的に抑制することができる。

【０２２６】
第１，第２の発明において、第１，第２の絶縁物層がSiO_2により構成されている場合には、本発明に従って、周波数温度特性ＴＣＦが改善された弾性表面波装置を提供することができる。

【０２２７】
ＩＤＴ電極がＣｕまたはＣｕを主成分とする合金からなる場合には、従来から弾性表面波装置の電極材料として汎用されてきたＡｌに比べて密度が大きいため、第１，第２の発明に従った弾性表面波装置を容易に構成することができ、かつ十分な反射係数のＩＤＴ電極を容易に形成することができる。

【０２２８】
第３の発明に係る製造方法では、圧電性基板２に第１絶縁物層を形成した後に、レジストパターンを用いてＩＤＴ電極が形成される部分の絶縁物層が除去され、残りの領域に第１絶縁物層とレジストとの積層構造が残留され、次に、第１絶縁物層が除去されている領域にＡｌよりも高密度の金属または該金属を主成分とする電極膜を形成することによりＩＤＴ電極が形成され、しかる後、第１絶縁物層上に残留しているレジストが除去される。そして、第１絶縁物層及びＩＤＴ電極上を被覆するように第２絶縁物層が形成されるため、第２絶縁物層上面の凹凸が生じ難い。従って、第２の絶縁物層表面の凹凸による特性の劣化が生じ難い。加えて、ＩＤＴ電極がＡｌよりも高密度の金属または該金属を主成分とする合金からなるため、ＩＤＴ電極の反射係数が高められ、所望でないリップルによる特性の劣化を抑制することができる。

【０２２９】
また、第４の発明によれば、ＩＤＴ電極を形成した後に、ＩＤＴ電極を構成する金属もしくは合金よりも耐腐食性に優れた金属もしくは合金からなる保護金属膜が形成され、しかる後、第１絶縁物層上のレジスト及び該レジスト上に積層されている保護金属膜が除去される。従って、レジスト剥離液によりこの除去工程を行うに際し、ＩＤＴ電極の側面が第１絶縁物層により、上面が保護金属層により覆われているため、ＩＤＴ電極の腐食が生じ難い。

【０２３０】
従って、ＩＤＴ電極の腐食を引き起こすことなく、第２の発明に係る弾性表面波装置を提

供することが可能となる。
第５の発明によれば、圧電基板上に電極を形成し、該電極を覆うように絶縁物層を形成した後に、電極が存在する部分と存在しない部分の上方における絶縁物層の表面の凹凸が平坦化される。従って、第１の発明と同様に、絶縁物層表面の凹凸による特性の劣化が生じ難い。
【図面の簡単な説明】
【図１】（ａ）～（ｇ）は、本発明の一実施例における弾性表面波装置の製造方法を説明するための各模式的部分切欠断面図。
【図２】オイラー角（０°，１２６°，０°）のＬｉＴａＯ$_3$基板上に、種々の膜厚でＡｌ、ＡｕまたはＰｔからなるＩＤＴ電極を形成し、さらに規格化膜厚ＨＳ／λが０．２のＳｉＯ$_2$膜を形成してなる１ポート型弾性表面波共振子において、ＳｉＯ$_2$膜の表面を平坦化した場合と平坦化していない場合の電極膜厚と反射係数との関係を示す図。
【図３】オイラー角（０°，１２６°，０°）のＬｉＴａＯ$_3$基板上に、種々の膜厚でＡｌ、ＣｕまたはＡｇからなるＩＤＴ電極を形成し、さらに規格化膜厚ＨＳ／λが０．２のＳｉＯ$_2$膜を形成してなる１ポート型弾性表面波共振子において、ＳｉＯ$_2$膜の表面を平坦化した場合と平坦化していない場合の電極膜厚と反射係数との関係を示す図。
【図４】比較例の製造方法で得られた弾性表面波共振子のＳｉＯ$_2$膜の規格化膜厚と、位相特性及びインピーダンス特性との関係を示す図。
【図５】比較のために用意した弾性表面波共振子におけるＳｉＯ$_2$膜の膜厚と、共振子のＭＦとの関係を示す図。
【図６】本発明の一実施例で得られた１ポート型弾性表面波共振子の模式的平面図。
【図７】実施例の製造方法において、ＳｉＯ$_2$膜の規格化膜厚を変化させた場合のインピーダンス特性及び位相特性の変化を示す図。
【図８】実施例及び比較例の製造方法により得られた弾性表面波共振子におけるＳｉＯ$_2$膜の膜厚と共振子のγとの関係を示す図。
【図９】実施例及び比較例の製造方法により得られた弾性表面波共振子におけるＳｉＯ$_2$膜の膜厚と共振子のＭＦとの関係を示す図。
【図１０】実施例及び比較例で用意された弾性表面波共振子におけるＳｉＯ$_2$膜の厚みと、周波数温度特性ＴＣＦの変化との関係を示す図。
【図１１】第２の比較例で用意されたＳｉＯ$_2$膜が形成された弾性表面波共振子と、ＳｉＯ$_2$膜を有しないインピーダンスー周波数特性を示す図。
【図１２】（ａ）～（ｅ）は、ＩＤＴ電極及び保護金属膜の平均密度の第１絶縁物層の密度に対する比を変化させた場合のインピーダンス特性の変化を示す図。
【図１３】オイラー角（０°，１２６°，０°）のＬｉＴａＯ$_3$基板上に様々な金属からなるＩＤＴ電極を様々な厚みで形成した場合の電気機械結合係数の変化を示す図。
【図１４】ＬｉＴａＯ$_3$基板上に様々な金属によりＩＤＴ電極を形成した場合に、Ａｌからなる電極を用いた場合に比べて電気機械結合係数が大きくなる電極膜厚範囲と電極材料との密度との関係を示す図。
【図１５】本発明の他の実施例に係る弾性表面波装置を示す斜視図。
【図１６】３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°））のＬｉＴａＯ$_3$基板上に、Ａｕ、Ｔａ、Ａｇ、Ｃｒ、Ｗ、Ｃｕ、Ｚｎ、Ｍｏ、ＮｉからなるＩＤＴ及びＡｌからなるＩＤＴを形成した場合のＩＤＴの規格化された電極膜厚と電気機械結合係数との関係を示す図。
【図１７】３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°）のＬｉＴａＯ$_3$基板上に各種電極材料からなるＩＤＴの電極指片方の反射係数と膜厚の関係を示す図。
【図１８】３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°））のＬｉＴａＯ$_3$基板上に、Ａｕ、Ｔａ、Ａｇ、Ｃｒ、Ｗ、Ｃｕ、Ｚｎ、Ｍｏ、ＮｉからなるＩＤＴ及びＡｌからなるＩＤＴを形成した場合の、ＩＤＴの電極規格化膜厚と減衰定数との関係を示す図。
【図１９】３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°））のＬｉＴａ

O_3基板上に、規格化膜厚が０．０２であるＡｕからなるＩＤＴを形成し、種々の膜厚のSiO_2膜を形成した場合の周波数温度特性（ＴＣＦ）の変化を示す図。
【図２０】３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°））のＬｉＴａO_3基板上に、種々の厚みのＡｕからなるＩＤＴを形成し、さらに上に積層されるＳｉＯ$_2$膜規格化膜厚を変化させた場合の減衰定数αの変化を示す図。
【図２１】３８°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２８°，０°））のＬｉＴａO_3基板上に、種々の厚みのＡｕからなるＩＤＴを形成し、さらに上に積層されるＳｉＯ$_2$膜規格化膜厚を変化させた場合の減衰定数αの変化を示す図。
【図２２】実施例の弾性表面波装置の減衰量周波数特性及びSiO_2膜成膜前の比較のための弾性表面波装置の減衰量周波数特性を示す図。
【図２３】３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°））のＬｉＴａO_3基板上に、ＡｕからなるＩＤＴを形成し、種々の膜厚のSiO_2膜を形成した構造において、ＡｕからなるＩＤＴの規格化膜厚を変化させた場合の漏洩弾性表面波の音速の変化を示す図。
【図２４】３６°回転Ｙ板Ｘ伝搬（オイラー角で（０°，１２６°，０°））のＬｉＴａO_3基板上に、種々の規格化膜厚のＡｕからなるＩＤＴを形成し、さらにSiO_2膜積層とした構造において、SiO_2膜の規格化膜厚を変化させた場合の漏洩弾性表面波の音速の変化を示す図。
【図２５】オイラー角で（０°，θ，０°）のθ、ＡｕからなるＩＤＴの規格化膜厚及びSiO_2膜の規格化膜厚を変化させた場合の電気機械結合係数の変化を示す図。
【図２６】ＬｉＴａO_3基板のオイラー角のθ及びSiO_2膜の規格化膜厚を変化させた場合の共振子のＱ値の変化を示す図。
【図２７】（ａ）～（ｃ）は、密着層が設けられた本発明の変形例に係る弾性表面波装置を説明するための各模式的断面図。
【図２８】SiO_2膜の膜厚Ｈ／λ＝０．１における各種Ａｕ電極膜厚における減衰定数αとθの関係を示す図。
【図２９】SiO_2膜の膜厚Ｈ／λ＝０．１５における各種Ａｕ電極膜厚における減衰定数αとθの関係を示す図。
【図３０】SiO_2膜の膜厚Ｈ／λ＝０．２における各種Ａｕ電極膜厚における減衰定数αとθの関係を示す図。
【図３１】SiO_2膜の膜厚Ｈ／λ＝０．２５における各種Ａｕ電極膜厚における減衰定数αとθの関係を示す図。
【図３２】SiO_2膜の膜厚Ｈ／λ＝０．３における各種Ａｕ電極膜厚における減衰定数αとθの関係を示す図。
【図３３】SiO_2膜の膜厚Ｈ／λ＝０．３５における各種Ａｕ電極膜厚における減衰定数αとθの関係を示す図。
【図３４】SiO_2膜の膜厚Ｈ／λ＝０．４における各種Ａｕ電極膜厚における減衰定数αとθの関係を示す図。
【図３５】SiO_2膜の膜厚Ｈ／λ＝０．４５における各種Ａｕ電極膜厚における減衰定数αとθの関係を示す図。
【図３６】オイラー角（０°，１２６°，０°）のＬｉＴａO_3基板上に、種々の膜厚のＡｇ膜からなる電極を形成した場合のＡｇ膜の規格化膜厚Ｈ／λと、電気機械結合係数K_{saw}との関係を示す図。
【図３７】オイラー角（０°，１１３°，０°）、（０°，１２６°，０°）及び（０°，１２９°，０°）の３種類のＬｉＴａO_3基板において、電極膜厚が０で、種々の膜厚のSiO_2膜を成膜した場合のSiO_2膜の規格化膜厚ＨＳ／λと周波数温度係数ＴＣＦとの関係を示す図。
【図３８】オイラー角（０°，１２０°，０°）のＬｉＴａO_3基板上に、０．１以下の規格化膜厚のＡｇ膜を形成し、０～０．５の規格化膜厚のSiO_2膜を成膜した場合の減衰定数αの変化を示す図。

【図39】オイラー角（0°，140°，0°）のLiTaO$_3$基板上に、0．1以下の規格化膜厚のAg膜を形成し、0～0．5の規格化膜厚のSiO$_2$膜を成膜した場合の減衰定数αの変化を示す図。
【図40】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Ag膜を形成し、規格化膜厚HS／λが0．1のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図41】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Ag膜を形成し、規格化膜厚HS／λが0．15のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図42】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Ag膜を形成し、規格化膜厚HS／λが0．2のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図43】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Ag膜を形成し、規格化膜厚HS／λが0．25のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図44】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Ag膜を形成し、規格化膜厚HS／λが0．3のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図45】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Ag膜を形成し、規格化膜厚HS／λが0．35のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図46】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Ag膜を形成し、規格化膜厚HS／λが0．4のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図47】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Ag膜を形成し、規格化膜厚HS／λが0．45のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図48】オイラー角（0°，120°，0°）のLiTaO$_3$基板上に、0．1以下の規格化膜厚のCu膜を形成し、0～0．5の規格化膜厚のSiO$_2$膜を成膜した場合の減衰定数αの変化を示す図。
【図49】オイラー角（0°，135°，0°）のLiTaO$_3$基板上に、0．1以下の規格化膜厚のCu膜を形成し、0～0．5の規格化膜厚のSiO$_2$膜を成膜した場合の減衰定数αの変化を示す図。
【図50】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Cu膜を形成し、規格化膜厚HS／λが0．1のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図51】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Cu膜を形成し、規格化膜厚HS／λが0．15のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図52】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Cu膜を形成し、規格化膜厚HS／λが0．2のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図53】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Cu膜を形成し、規格化膜厚HS／λが0．25のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図54】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Cu膜を形成し、規格化膜厚HS／λが0．3のSiO$_2$膜を積層した場合の、減衰定数αの変化を示す図。
【図55】オイラー角（0°，θ，0°）のLiTaO$_3$基板上に、規格化膜厚H／λが0．1以下の各種Cu膜を形成し、規格化膜厚HS／λが0．35のSiO$_2$膜を積層し

た場合の、減衰定数αの変化を示す図。

【図５６】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、規格化膜厚Ｈ／λが０．１以下の各種Ｃｕ膜を形成し、規格化膜厚ＨＳ／λが０．４のＳｉO_2膜を積層した場合の、減衰定数αの変化を示す図。

【図５７】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、規格化膜厚Ｈ／λが０．１以下の各種Ｃｕ膜を形成し、規格化膜厚ＨＳ／λが０．４５のＳｉO_2膜を積層した場合の、減衰定数αの変化を示す図。

【図５８】ＳｉO_2膜の規格化膜厚が０．０２のときのＡｌからなる電極及びＣｕからなる電極における電極指１本当りの反射率と電極膜厚との関係を示す図。

【図５９】減衰定数が０もしくは最小となるθ_{min}を実現するためのＳｉO_2膜の規格化膜厚ＨＳ／λと、Ｃｕ膜の規格化膜厚Ｈ／λとの関係を示す図。

【図６０】オイラー角（０°，１２０°，０°）のＬｉＴａO_3基板上に、様々な厚みのＳｉO_2膜及び様々な厚みのタングステンからなるＩＤＴを形成した構造における減衰定数αの変化を示す図。

【図６１】オイラー角（０°，１４０°，０°）のＬｉＴａO_3基板上に、様々な厚みのＳｉO_2膜及び様々な厚みのタングステンからなるＩＤＴを形成した構造における減衰定数αの変化を示す図。

【図６２】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのタングステンよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．１のＳｉO_2膜を形成した弾性表面波装置におけるθと、タングステンよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。

【図６３】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのタングステンよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．２のＳｉO_2膜を形成した弾性表面波装置におけるθと、タングステンよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。

【図６４】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのタングステンよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．３のＳｉO_2膜を形成した弾性表面波装置におけるθと、タングステンよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。

【図６５】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのタングステンよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．４のＳｉO_2膜を形成した弾性表面波装置におけるθと、タングステンよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。

【図６６】オイラー角（０°，１２６°，０°）のＬｉＴａO_3基板上にタングステンからなるＩＤＴを形成し、さらにＳｉO_2膜を形成した場合のタングステン膜の膜厚と、ＳｉO_2膜の膜厚と、音速との関係を示す図。

【図６７】オイラー角（０°，１２６°，０°）のＬｉＴａO_3基板上にタングステンからなるＩＤＴを形成し、さらにＳｉO_2膜を形成した場合のタングステン膜の膜厚と、ＳｉO_2膜の膜厚と、音速との関係を示す図。

【図６８】オイラー角（０°，１２０°，０°）のＬｉＴａO_3基板上に、様々な厚みのＳｉO_2膜及び様々な厚みのタンタルからなるＩＤＴを形成した構造における減衰定数αの変化を示す図。

【図６９】オイラー角（０°，１４０°，０°）のＬｉＴａO_3基板上に、様々な厚みのＳｉO_2膜及び様々な厚みのタンタルからなるＩＤＴを形成した構造における減衰定数αの変化を示す図。

【図７０】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのタンタルよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．１のＳｉO_2膜を形成した弾性表面波装置におけるθと、タンタルよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。

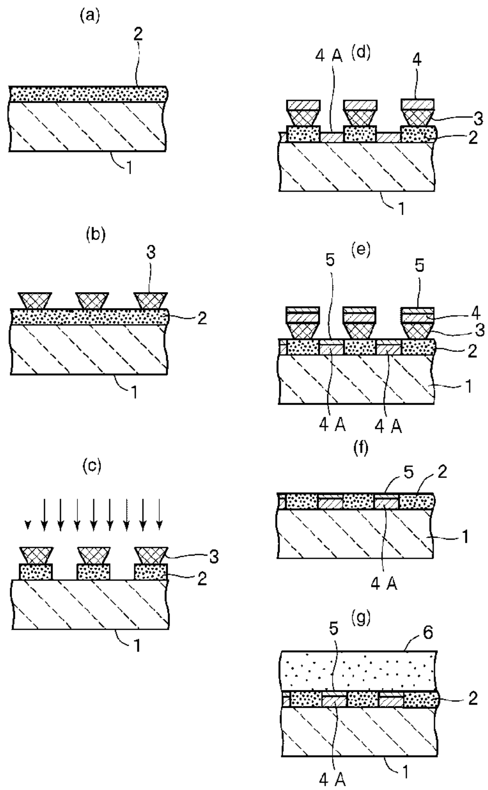
【図７１】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのタンタ

ルよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．２のSiO_2膜を形成した弾性表面波装置におけるθと、タンタルよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図７２】オイラー角（０°，θ，０°）の$LiTaO_3$基板上に、様々な厚みのタンタルよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．３のSiO_2膜を形成した弾性表面波装置におけるθと、タンタルよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図７３】オイラー角（０°，θ，０°）の$LiTaO_3$基板上に、様々な厚みのタンタルよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．４のSiO_2膜を形成した弾性表面波装置におけるθと、タンタルよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図７４】オイラー角（０°，１２６°，０°）の$LiTaO_3$基板上にタンタルからなるＩＤＴを形成し、その上にSiO_2膜を形成した構造における、タンタルの規格化膜厚と、SiO_2の規格化膜厚と、音速との関係を示す図。
【図７５】オイラー角（０°，１２６°，０°）の$LiTaO_3$基板上にタンタルからなるＩＤＴが形成されており、その上にSiO_2膜が形成された構造における、タンタルの規格化膜厚と、SiO_2の規格化膜厚と、音速との関係を示す図。
【図７６】オイラー角（０°，１２５°，０°）の$LiTaO_3$基板上に、様々な厚みのSiO_2膜及び様々な厚みの白金からなるＩＤＴを形成した構造における減衰定数αの変化を示す図。
【図７７】オイラー角（０°，１４０°，０°）の$LiTaO_3$基板上に、様々な厚みのSiO_2膜及び様々な厚みの白金からなるＩＤＴを形成した構造における減衰定数αの変化を示す図。
【図７８】オイラー角（０°，θ，０°）の$LiTaO_3$基板上に、様々な厚みの白金よりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．１のSiO_2膜を形成した弾性表面波装置におけるθと、白金よりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図７９】オイラー角（０°，θ，０°）の$LiTaO_3$基板上に、様々な厚みの白金よりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．１５のSiO_2膜を形成した弾性表面波装置におけるθと、白金よりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図８０】オイラー角（０°，θ，０°）の$LiTaO_3$基板上に、様々な厚みの白金よりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．２のSiO_2膜を形成した弾性表面波装置におけるθと、白金よりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図８１】オイラー角（０°，θ，０°）の$LiTaO_3$基板上に、様々な厚みの白金よりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．２５のSiO_2膜を形成した弾性表面波装置におけるθと、白金よりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図８２】オイラー角（０°，θ，０°）の$LiTaO_3$基板上に、様々な厚みの白金よりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．３のSiO_2膜を形成した弾性表面波装置におけるθと、白金よりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図８３】オイラー角（０°，θ，０°）の$LiTaO_3$基板上に、様々な厚みの白金よりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．４のSiO_2膜を形成した弾性表面波装置におけるθと、白金よりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図８４】オイラー角（０°，１２６°，０°）の$LiTaO_3$基板上に白金からなるＩＤＴを形成し、さらにSiO_2膜を形成した場合の白金膜の膜厚と、SiO_2膜の膜厚と、音速との関係を示す図。

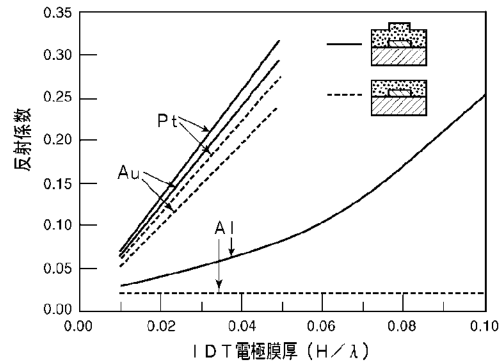
【図８５】オイラー角（０°，１２６°，０°）のＬｉＴａO_3基板上に白金からなるＩＤＴを形成し、さらにＳｉO_2膜を形成した場合の白金膜の膜厚と、ＳｉO_2膜の膜厚と、音速との関係を示す図。
【図８６】オイラー角（０°，１２０°，０°）のＬｉＴａO_3基板上に、様々な厚みのＳｉO_2膜及び様々な厚みのニッケルからなるＩＤＴを形成した構造における減衰定数αの変化を示す図。
【図８７】オイラー角（０°，１４０°，０°）のＬｉＴａO_3基板上に、様々な厚みのＳｉO_2膜及び様々な厚みのニッケルからなるＩＤＴを形成した構造における減衰定数αの変化を示す図。
【図８８】オイラー角（０°，１２０°，０°）のＬｉＴａO_3基板上に、様々な厚みのＳｉO_2膜及び様々な厚みのモリブデンからなるＩＤＴを形成した構造における減衰定数αの変化を示す図。
【図８９】オイラー角（０°，１４０°，０°）のＬｉＴａO_3基板上に、様々な厚みのＳｉO_2膜及び様々な厚みのモリブデンからなるＩＤＴを形成した構造における減衰定数αの変化を示す図。
【図９０】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのニッケルよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．１のＳｉO_2膜を形成した弾性表面波装置におけるθと、ニッケルよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図９１】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのニッケルよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．２のＳｉO_2膜を形成した弾性表面波装置におけるθと、ニッケルよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図９２】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのニッケルよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．３のＳｉO_2膜を形成した弾性表面波装置におけるθと、ニッケルよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図９３】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのニッケルよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．４のＳｉO_2膜を形成した弾性表面波装置におけるθと、ニッケルよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図９４】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのモリブデンよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．１のＳｉO_2膜を形成した弾性表面波装置におけるθと、モリブデンよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図９５】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのモリブデンよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．２のＳｉO_2膜を形成した弾性表面波装置におけるθと、モリブデンよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図９６】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのモリブデンよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．３のＳｉO_2膜を形成した弾性表面波装置におけるθと、モリブデンよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図９７】オイラー角（０°，θ，０°）のＬｉＴａO_3基板上に、様々な厚みのモリブデンよりなる電極膜を形成し、さらに規格化膜厚ＨＳ／λ＝０．４のＳｉO_2膜を形成した弾性表面波装置におけるθと、モリブデンよりなる電極膜の規格化厚みＨ／λと、減衰定数αとの関係を示す図。
【図９８】オイラー角（０°，１２６°，０°）のＬｉＴａO_3基板上にニッケルからなるＩＤＴが形成されており、さらに様々な厚みのＳｉO_2膜が形成された場合のニッケル膜の膜厚と、ニッケル膜の膜厚と、音速との関係を示す図。

【図９９】オイラー角（０°，１２６°，０°）のＬｉＴａＯ$_3$基板上に、様々な膜厚のニッケルからなるＩＤＴが形成されており、その上にＳｉＯ$_2$膜が形成されてい構造における、ＳｉＯ$_2$膜の膜厚と、音速との関係を示す図。
【図１００】オイラー角（０°，１２６°，０°）のＬｉＴａＯ$_3$基板上にモリブデンからなるからなるＩＤＴが形成されており、その上に様々な膜厚のＳｉＯ$_2$膜が形成された場合構造におけるモリブデンの規格化膜厚と、音速との関係を示す図。
【図１０１】オイラー角（０°，１２６°，０°）のＬｉＴａＯ$_3$基板上に様々な膜厚のモリブデンからなるＩＤＴを形成し、さらにＳｉＯ$_2$膜を形成した構造における、ＳｉＯ$_2$膜の規格化膜厚と、音速との関係を示す図。
【図１０２】（ａ）～（ｃ）は、絶縁物層表面の平坦化を図る方法の一例としてのエッチバック法を説明するための各模式的断面図。
【図１０３】（ａ）～（ｄ）は、絶縁物層表面を平坦化する方法の他の例としての逆スパッタ法を説明するための各模式的断面図。
【図１０４】（ａ）及び（ｂ）は、絶縁物層表面を平坦化する方法のさらに他の例を示す模式的断面図である。
【図１０５】（ａ）～（ｃ）は、絶縁物層表面を平坦化するさらに別の方法を説明するための各模式的断面図。
【図１０６】（ａ）及び（ｂ）は、本発明が適用される弾性表面波装置の一例としての１ポート型共振子及び２ポート型共振子を説明するための各模式的平面図。
【図１０７】本発明が適用される弾性表面波装置としてのラダー型フィルタを説明するための模式的平面図。
【図１０８】本発明が適用される弾性表面波装置としてのラチス型フィルタを説明するための模式的平面図。
【図１０９】（ａ）～（ｄ）は、従来の弾性表面波装置の製造方法の一例を示すための模式的断面図。
【図１１０】従来の弾性表面波装置の一例を説明するための模式的正面断面図。。
【符号の説明】
１　ＬｉＴａＯ$_3$基板
２　第１絶縁物層
３　レジストパターン
４　金属膜
４Ａ　ＩＤＴ電極
５　保護金属膜としてのＴｉ膜
６　第２絶縁物層
１１　弾性表面波共振子
１２，１３　反射器
２１　弾性表面波装置
２２　ＬｉＴａＯ$_3$基板
２３ａ，２３ｂ　ＩＤＴ
２５　ＳｉＯ$_2$膜

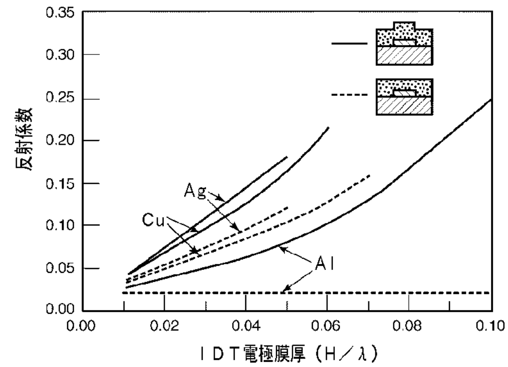
【図１】



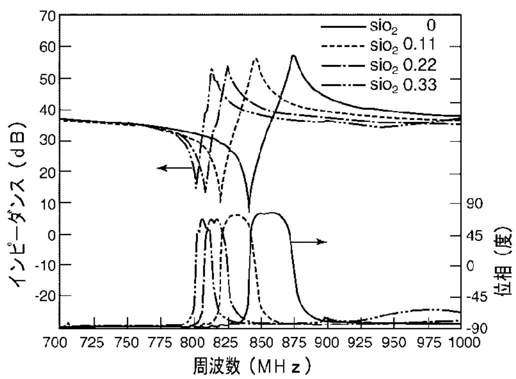
【図２】



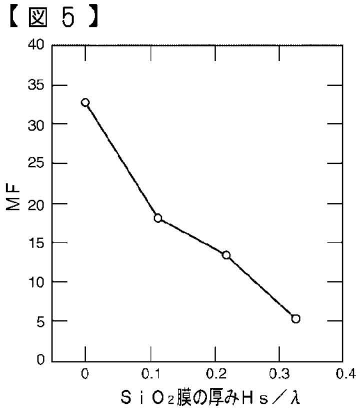
【図３】



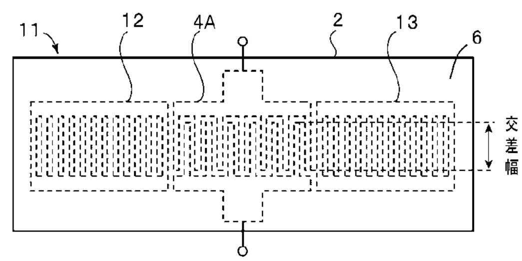
【図４】



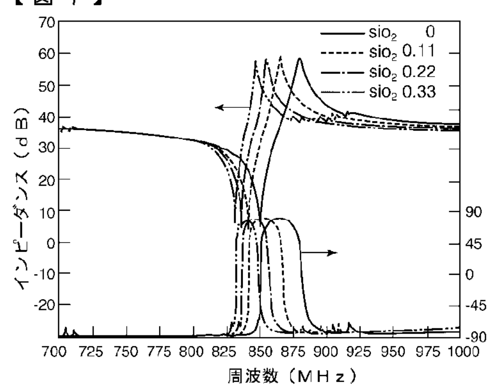
【図５】



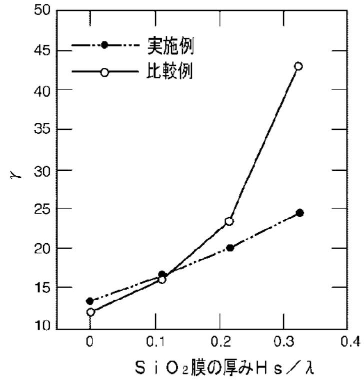
【図６】



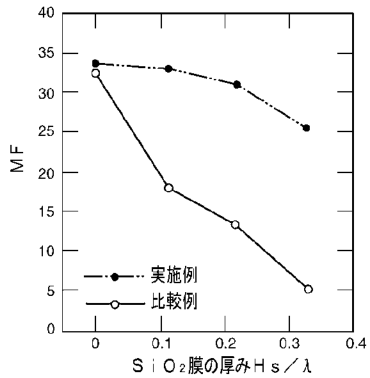
【図７】



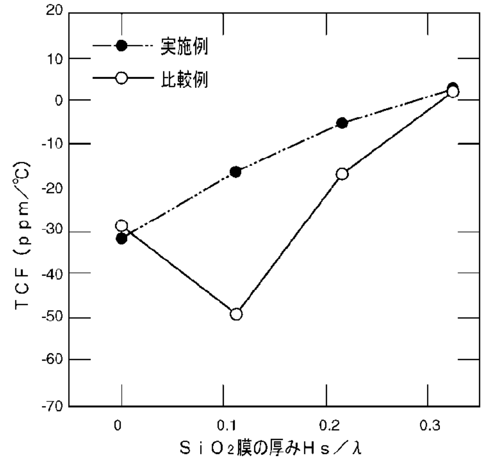
【図８】



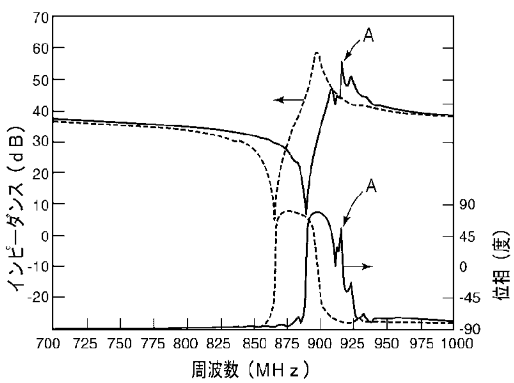
【図９】



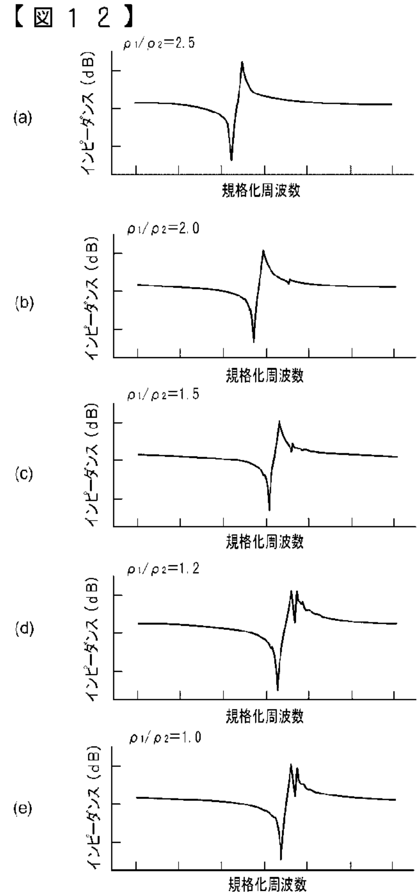
【図１０】



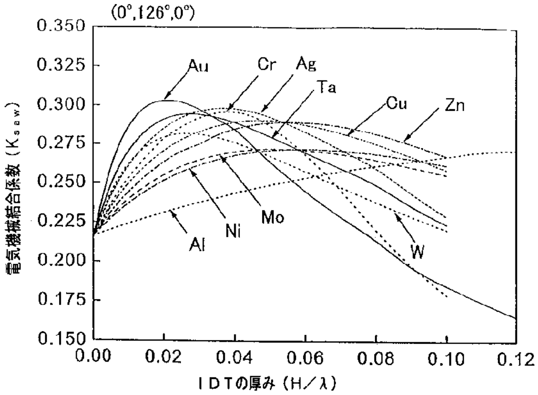
【図１１】



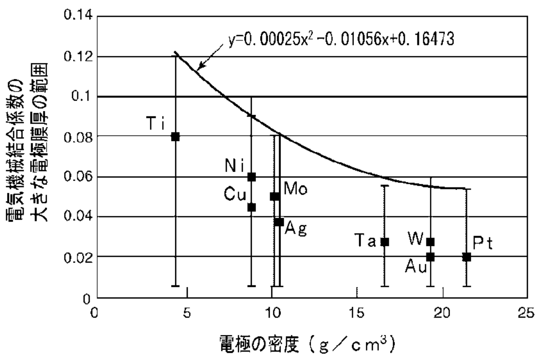
【図１２】



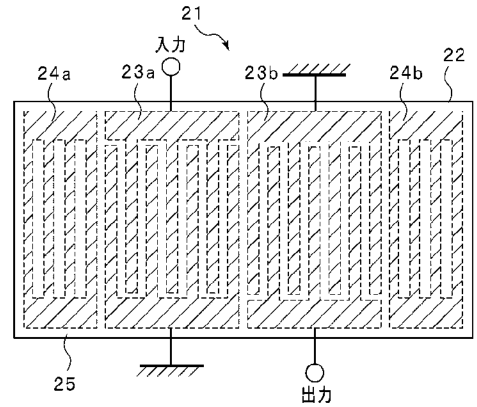
【図１３】



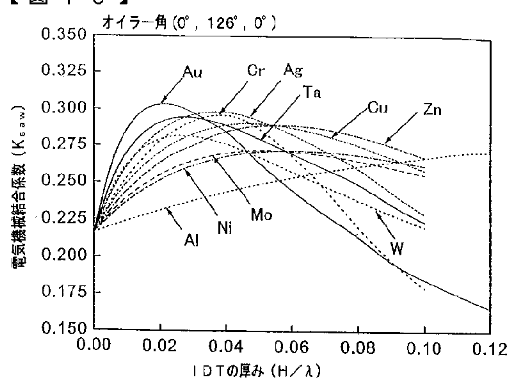
【図１４】



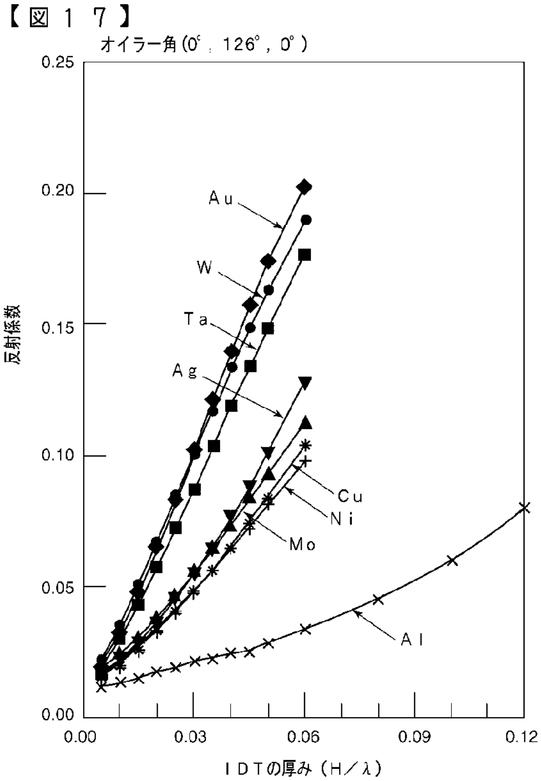
【図１５】



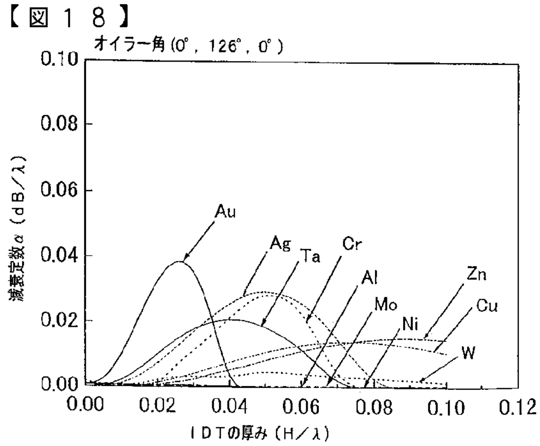
【図１６】



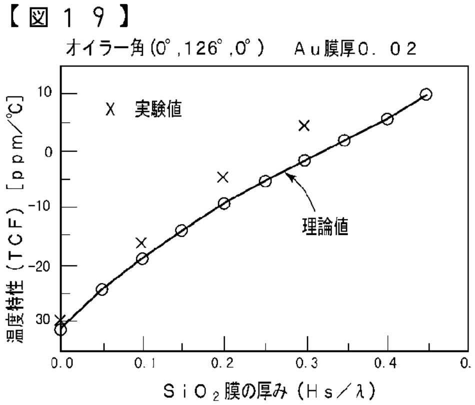
【図１７】



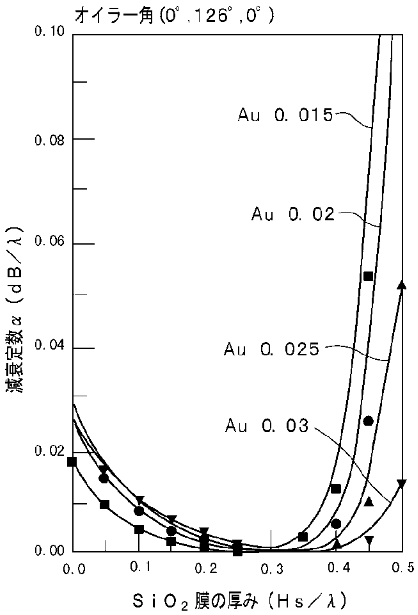
【図１８】



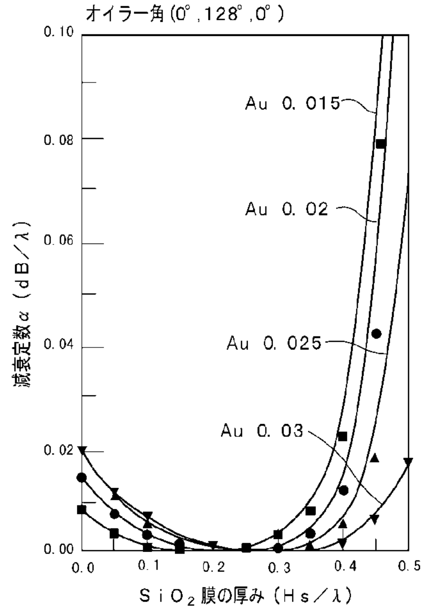
【図１９】



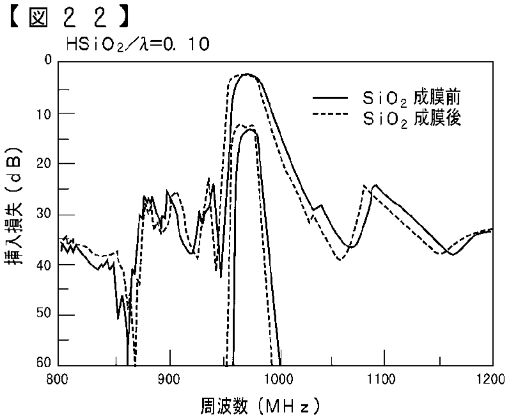
【図２０】



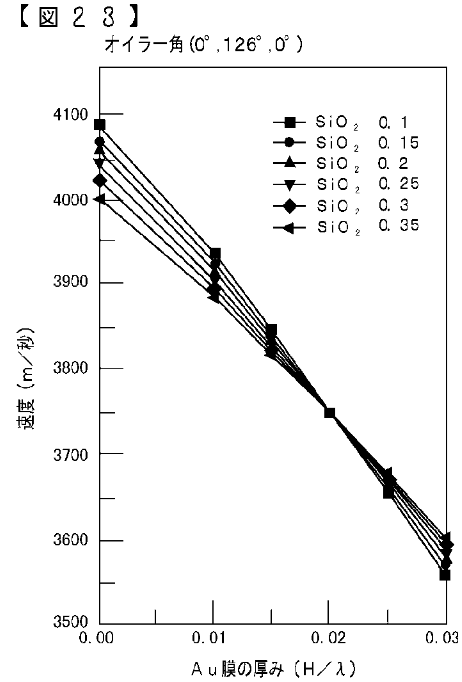
【図２１】



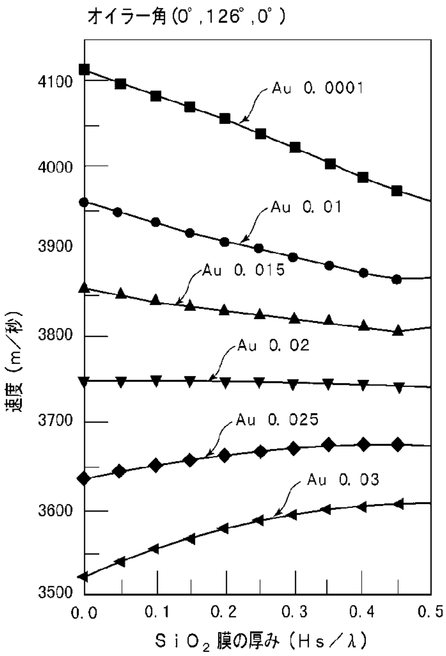
【図２２】



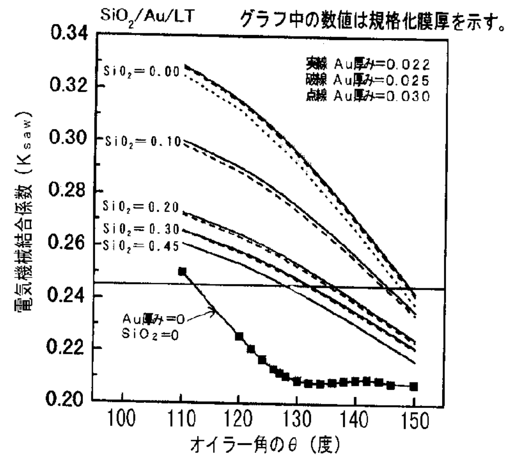
【図２３】



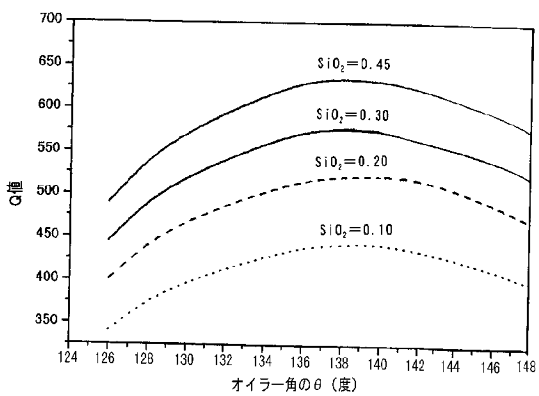
【図２４】



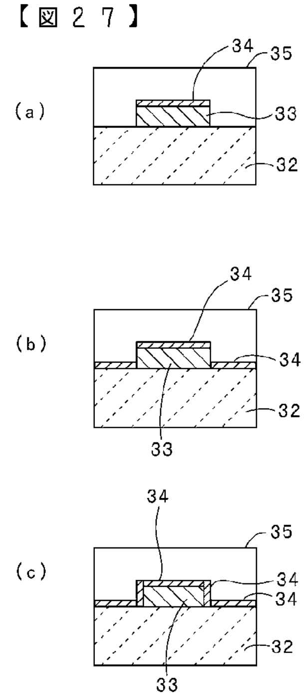
【図２５】



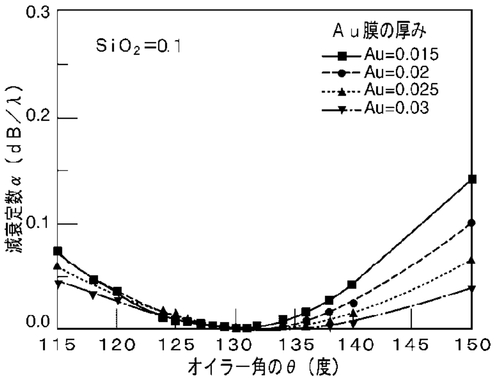
【図２６】



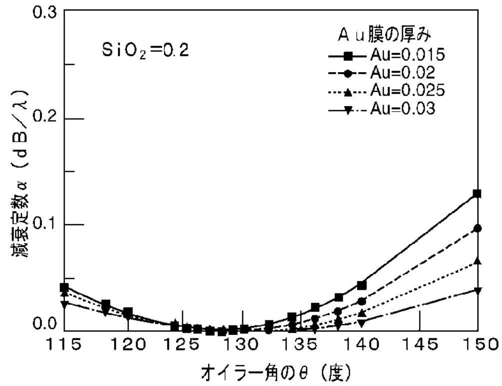
【図２７】



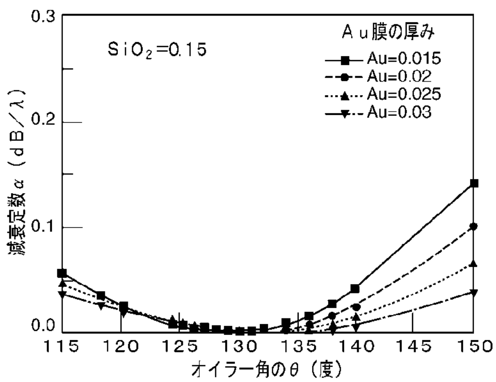
【図２８】



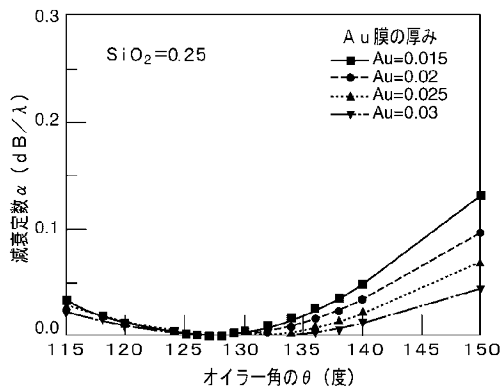
【図３０】



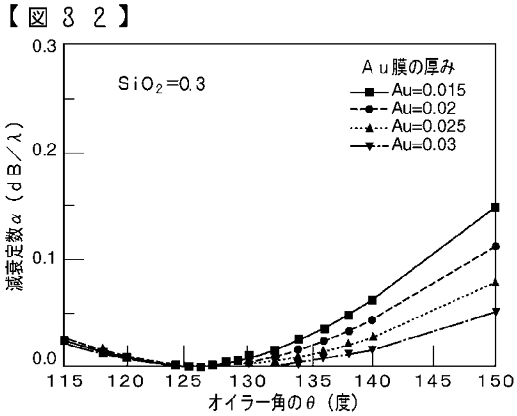
【図２９】



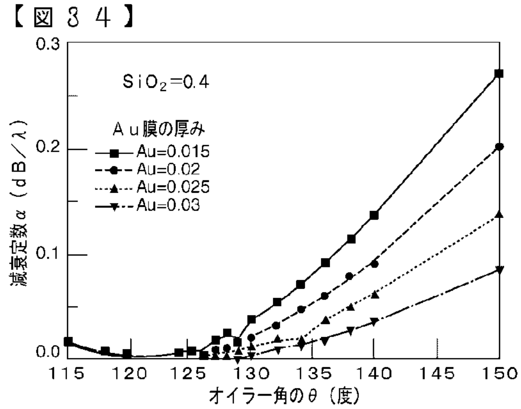
【図３１】



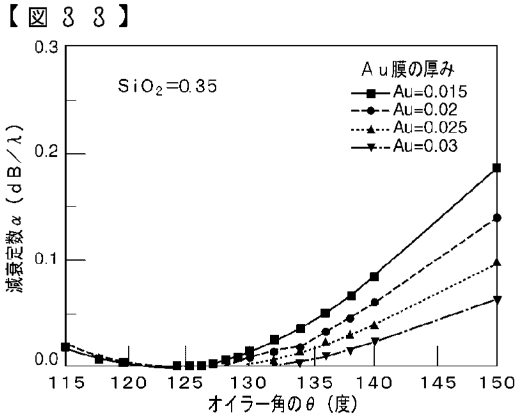
【図３２】



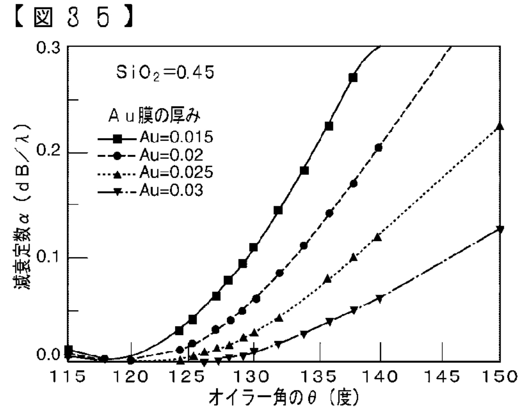
【図３４】



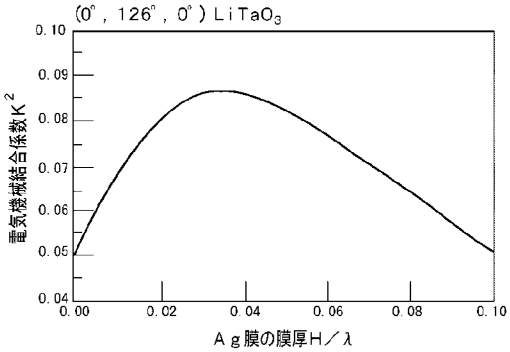
【図３３】



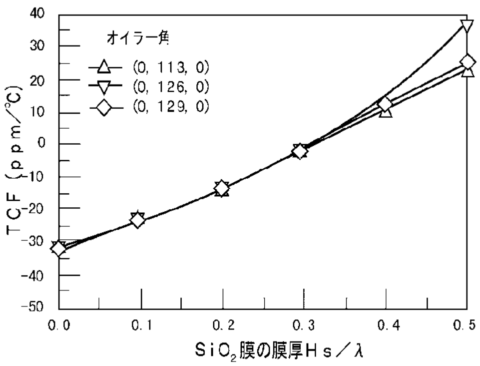
【図３５】



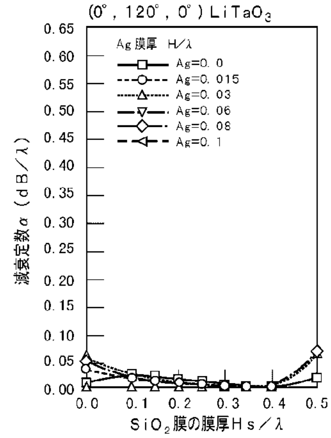
【図３６】



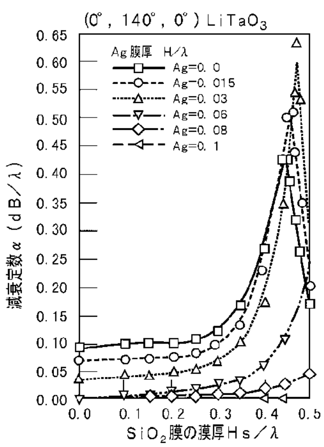
【図３７】



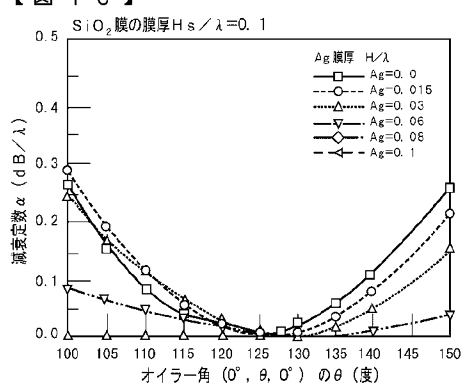
【図３８】



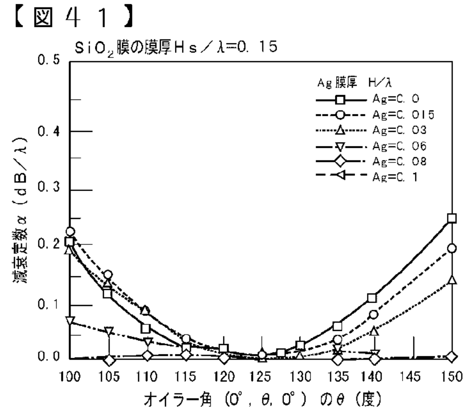
【図３９】



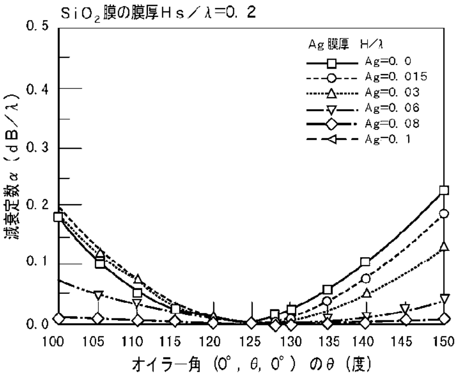
【図４０】



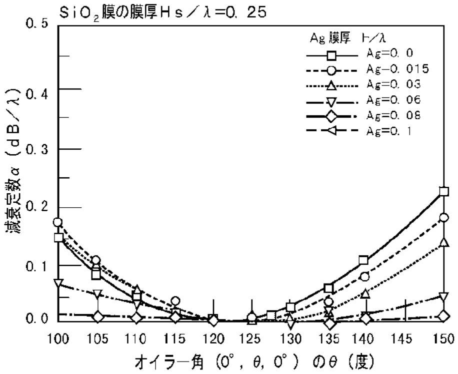
【図４１】



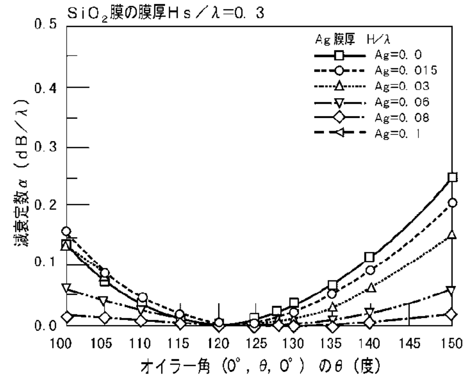
【図４２】



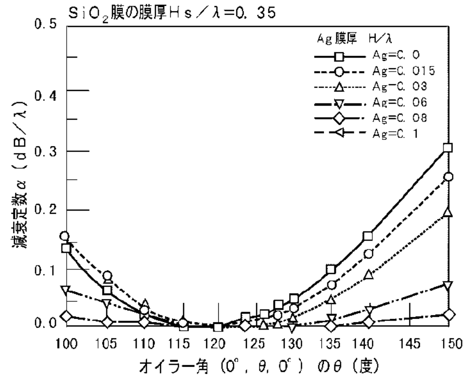
【図４３】



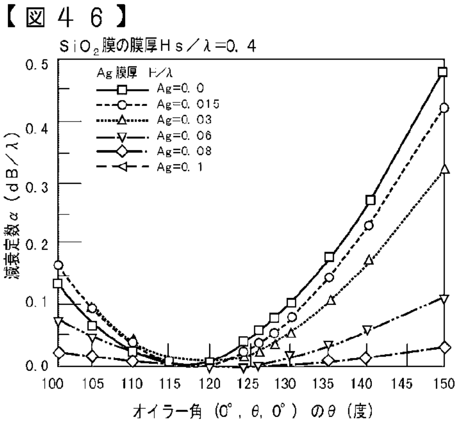
【図４４】



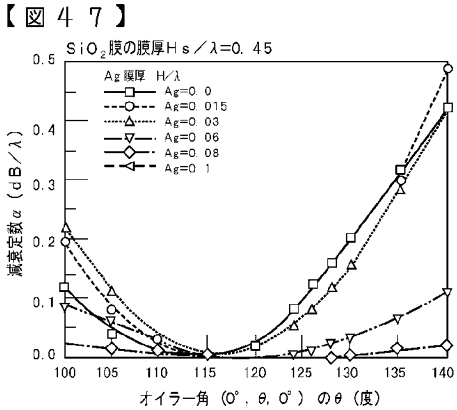
【図４５】



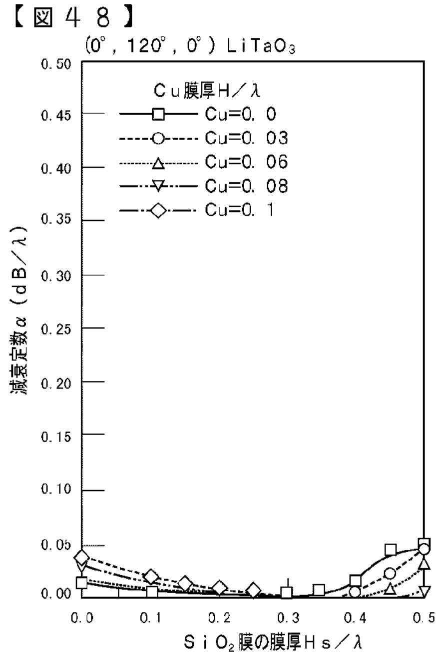
【図４６】



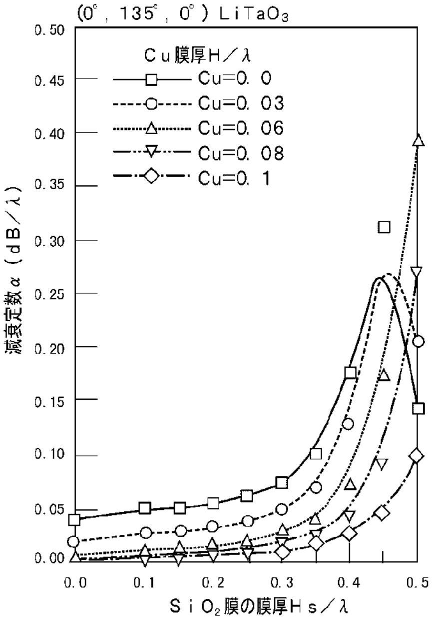
【図４７】



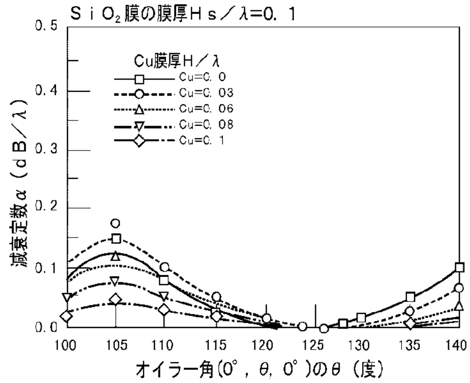
【図４８】



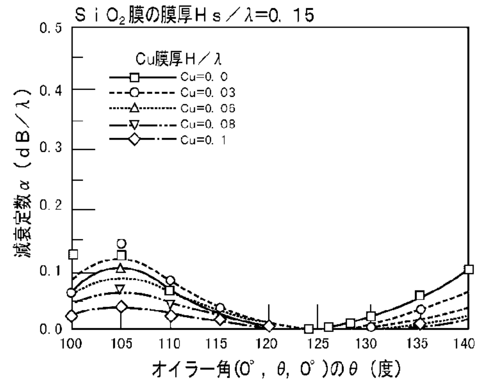
【図４９】



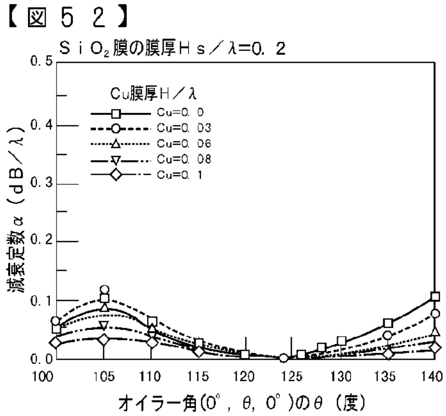
【図５０】



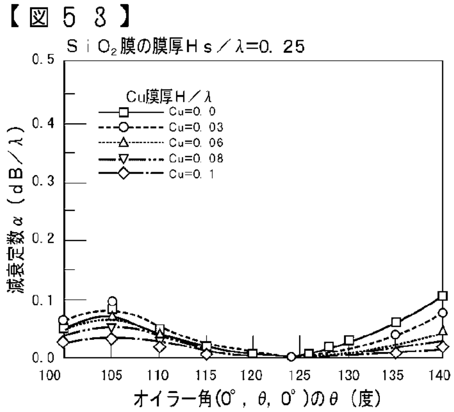
【図５１】



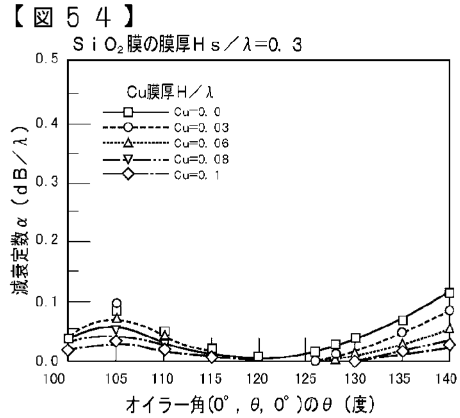
【図５２】



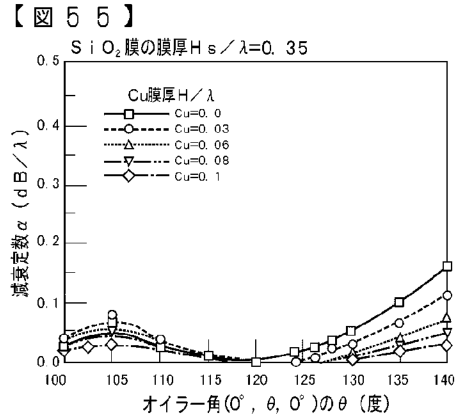
【図５３】



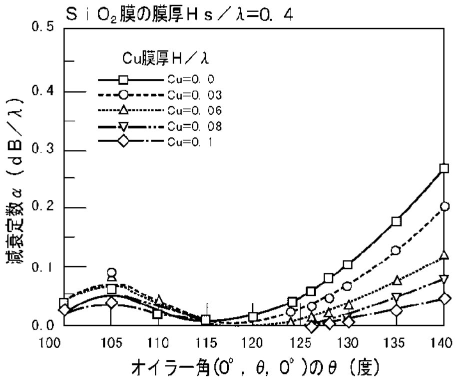
【図５４】



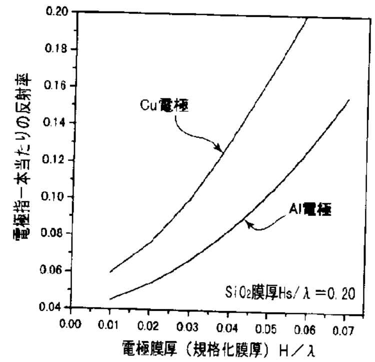
【図５５】



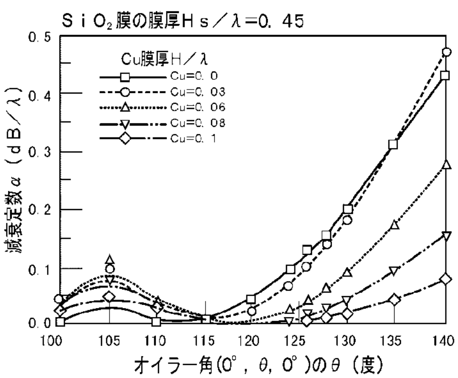
【図５６】



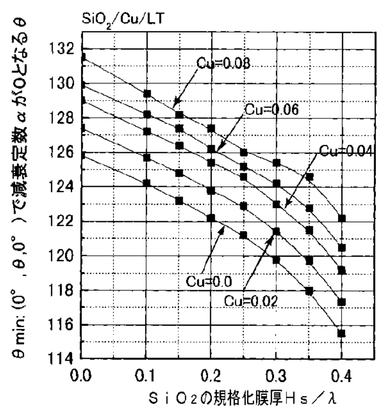
【図５８】



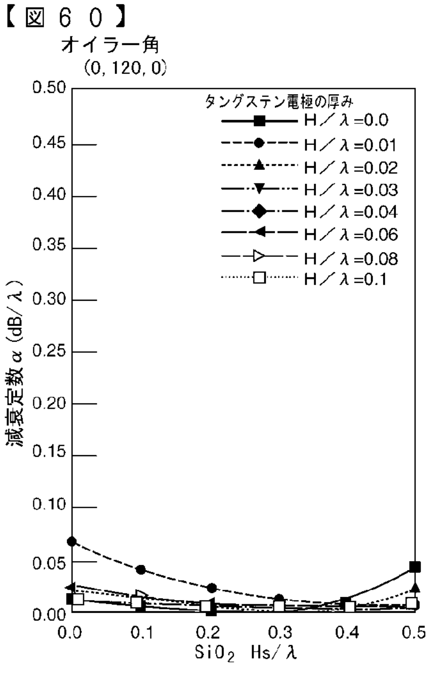
【図５７】



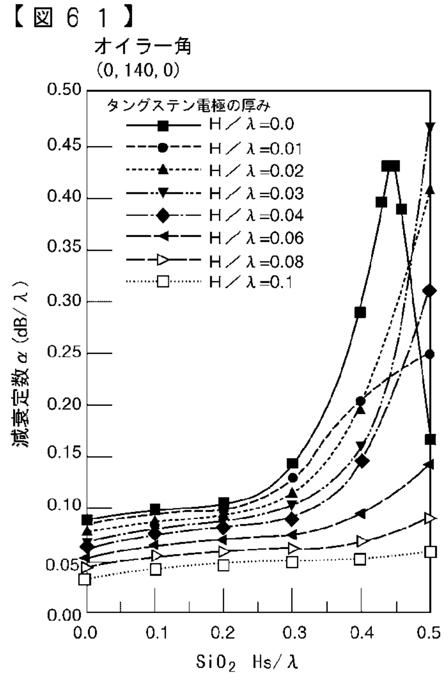
【図５９】



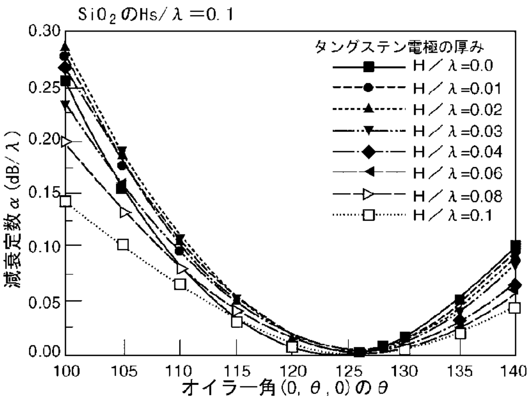
【図６０】



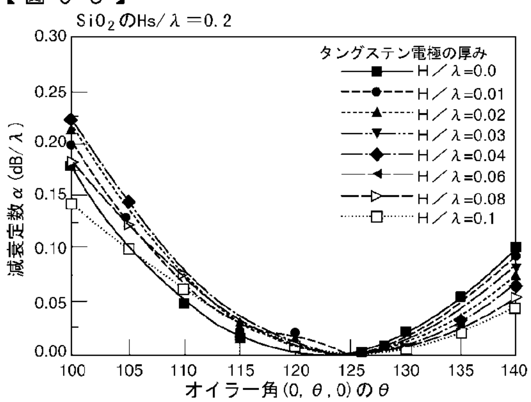
【図６１】



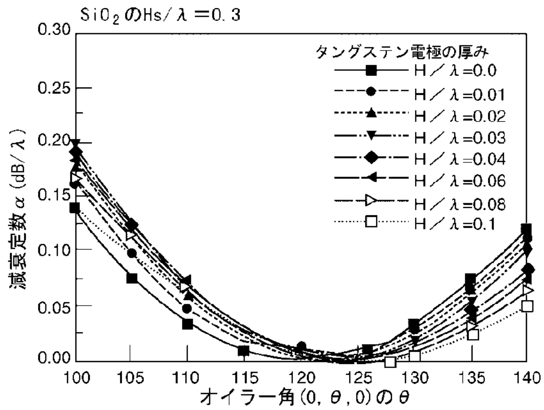
【図６２】



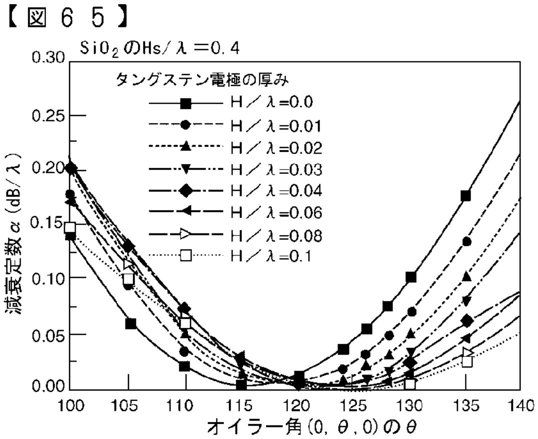
【図６３】



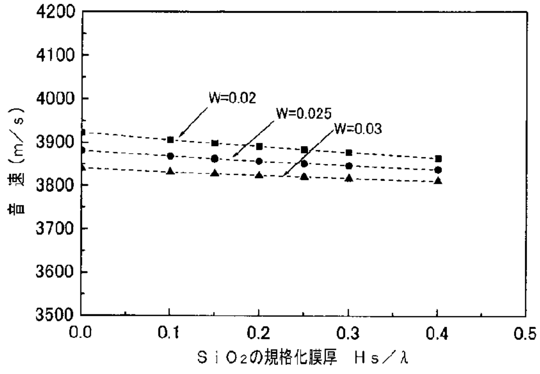
【図６４】



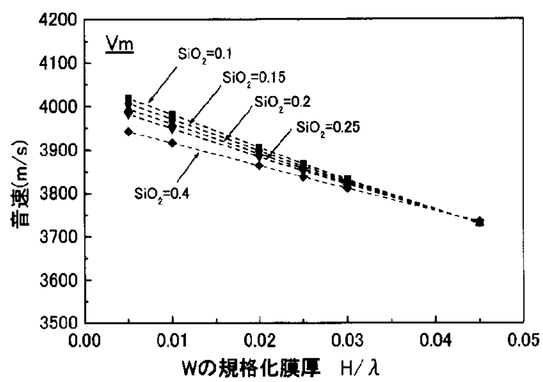
【図６５】



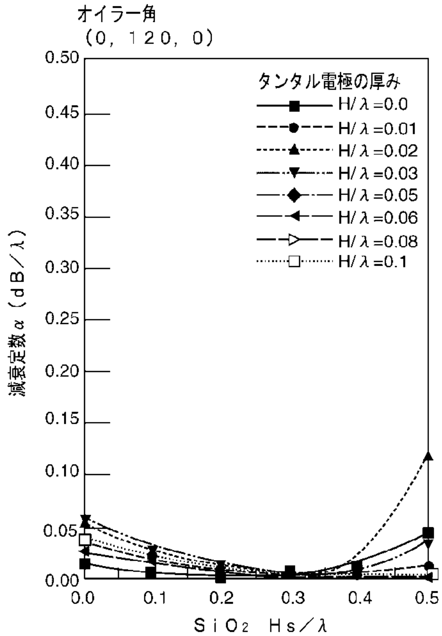
【図６６】



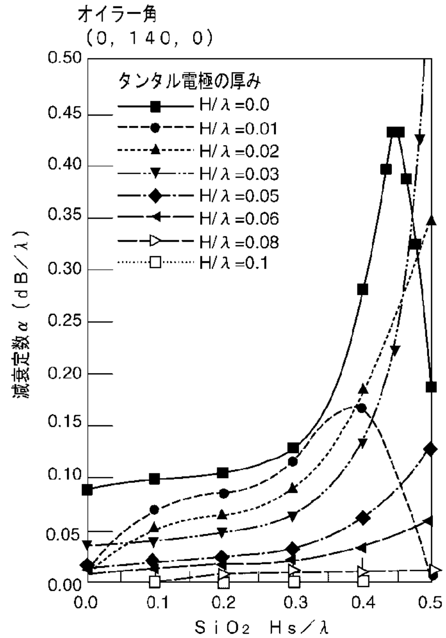
【図６７】



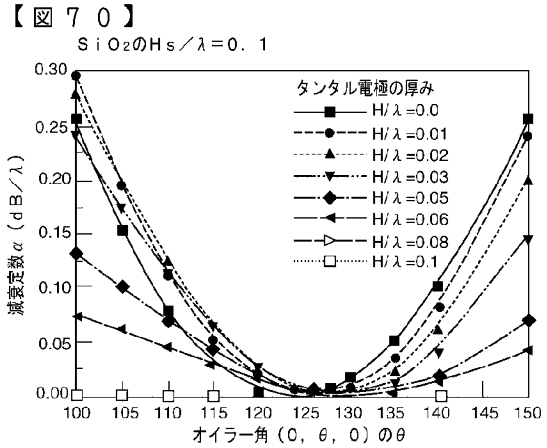
【図６８】



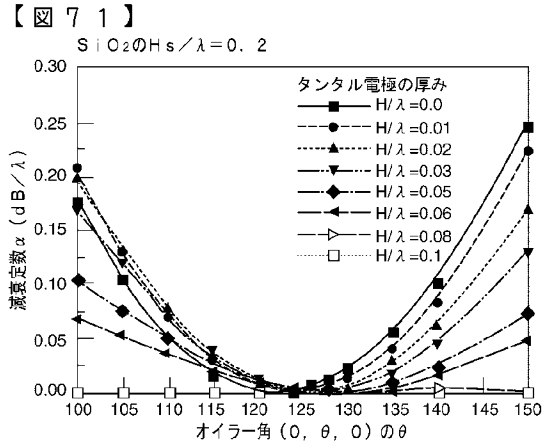
【図６９】



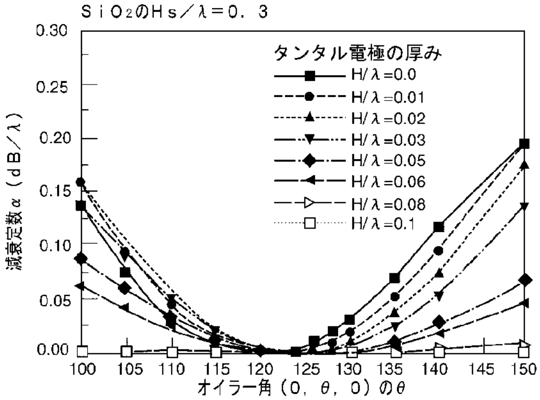
【図７０】



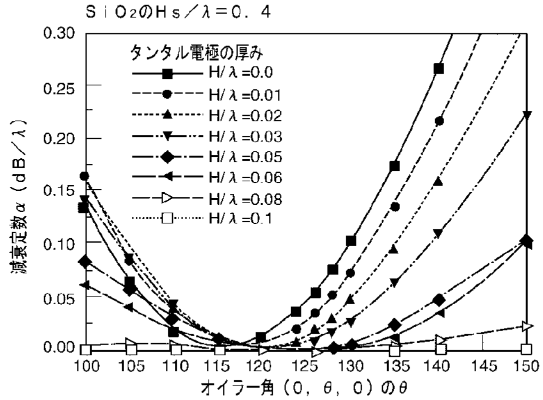
【図７１】



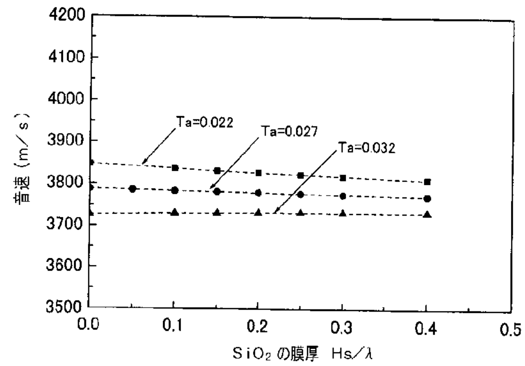
【図７２】



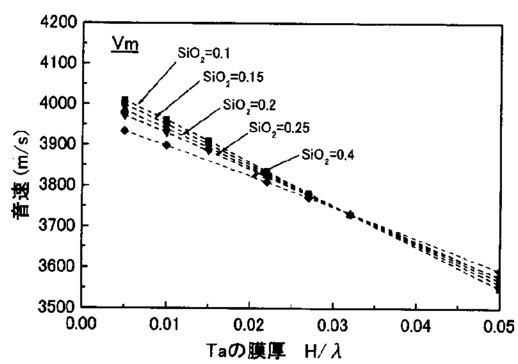
【図７３】



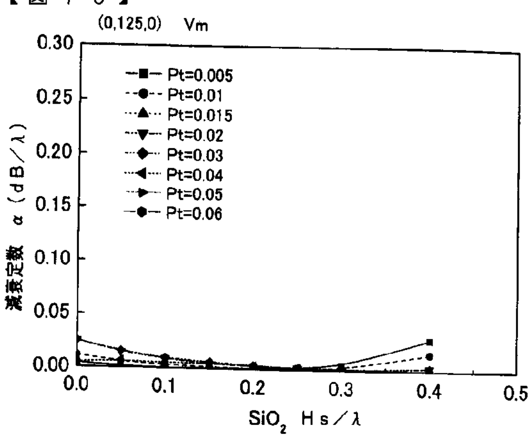
【図７４】



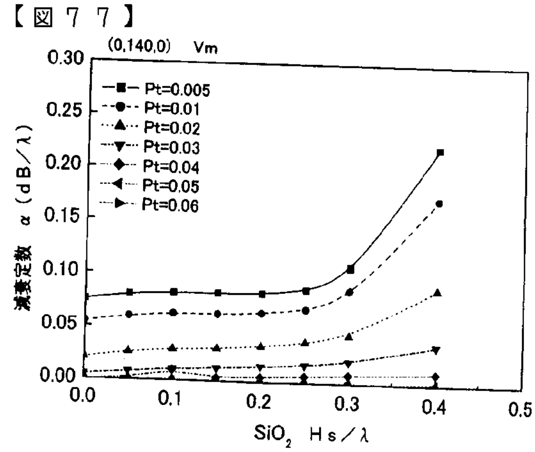
【図７５】



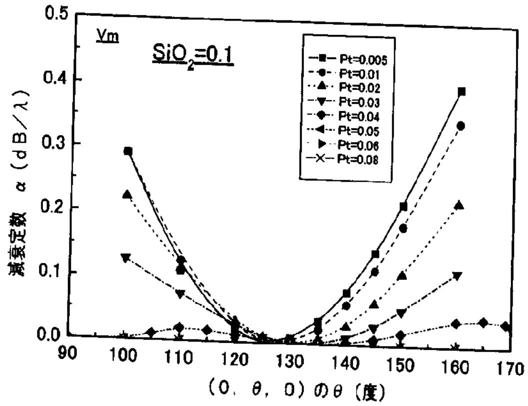
【図７６】



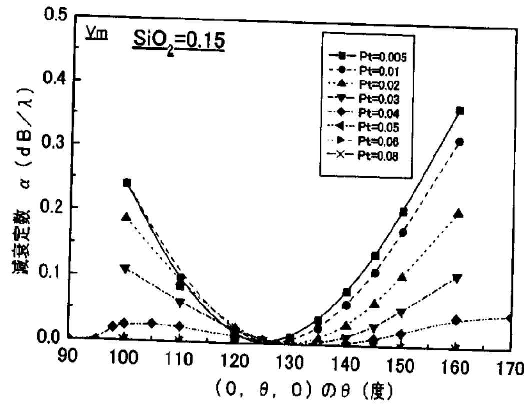
【図７７】



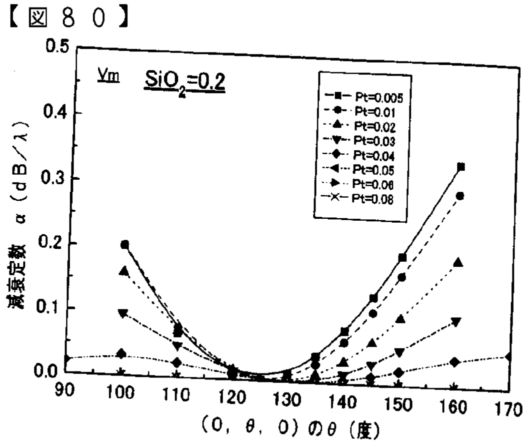
【図７８】



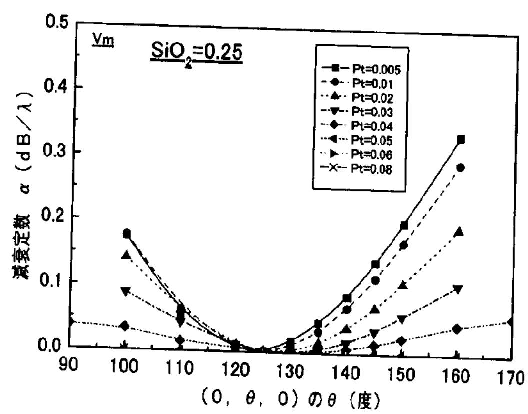
【図７９】



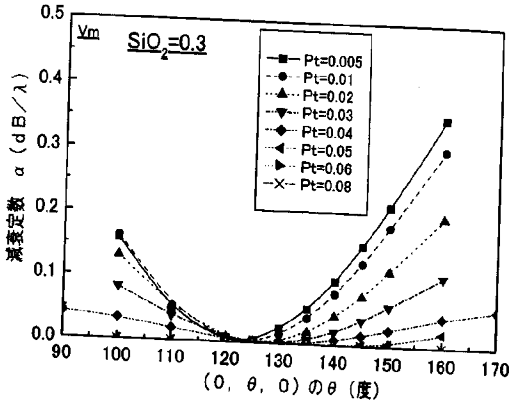
【図８０】



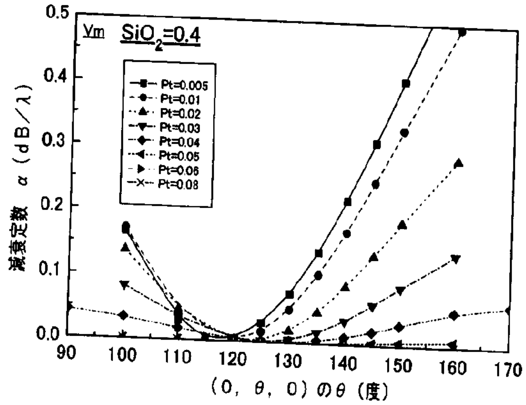
【図８１】



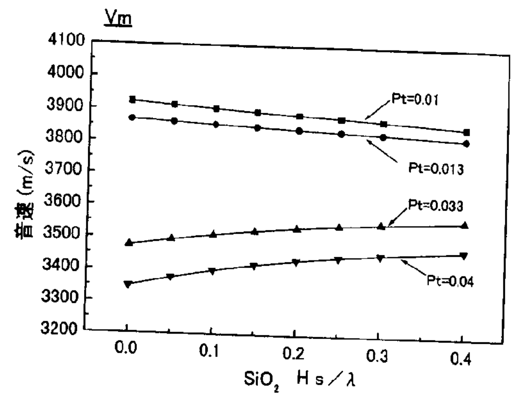
【図８２】



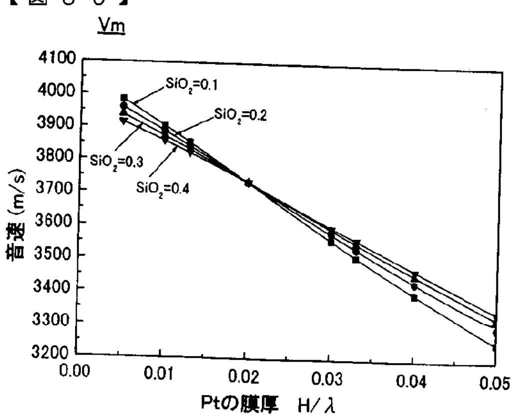
【図８３】



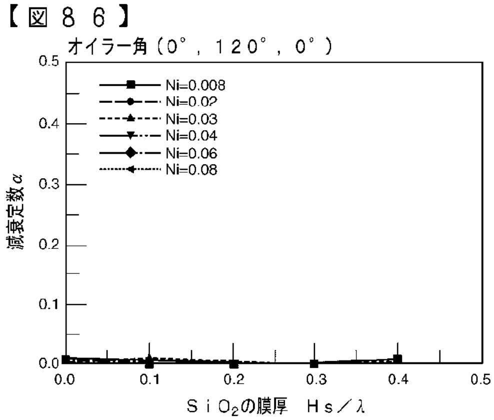
【図８４】



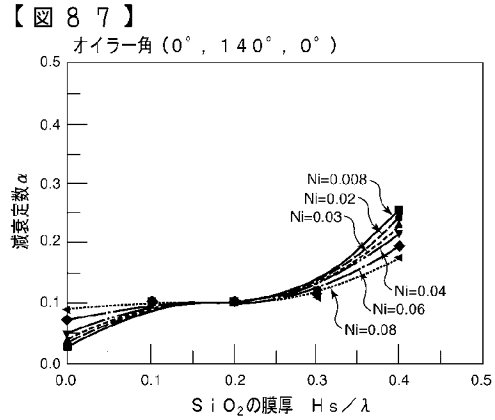
【図８５】



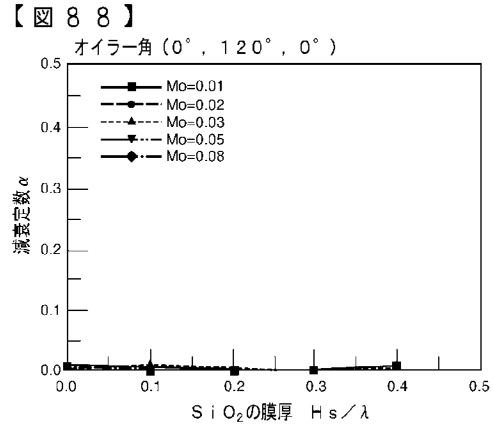
【図８６】



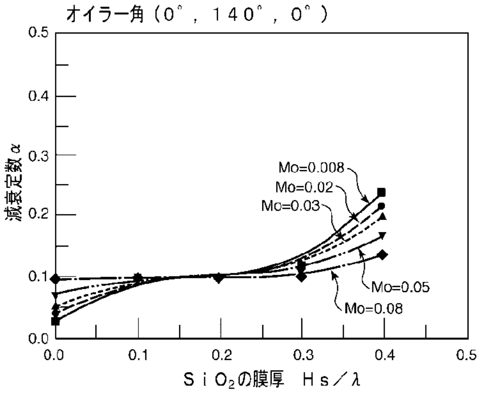
【図８７】



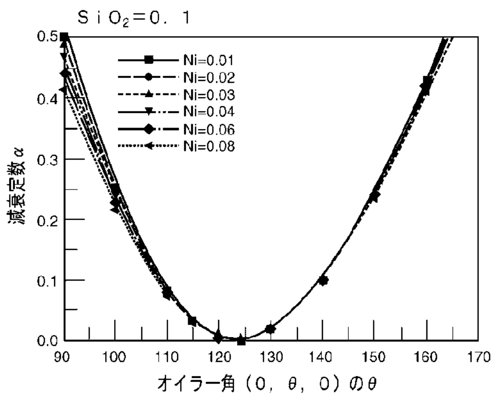
【図８８】



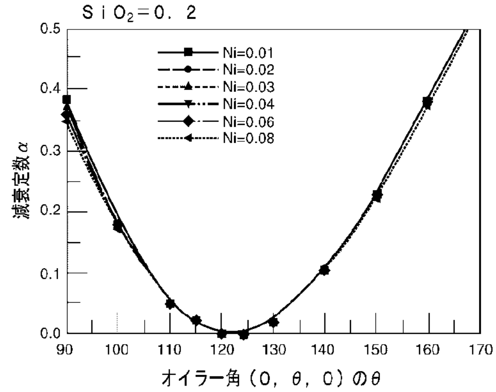
【図８９】



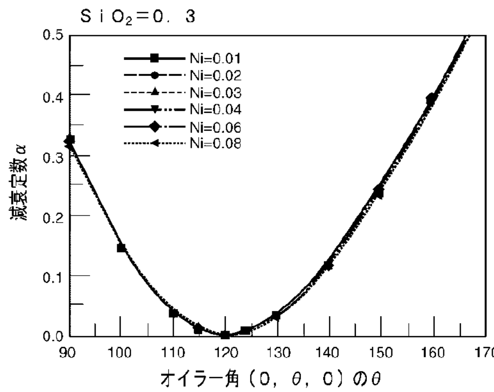
【図９０】



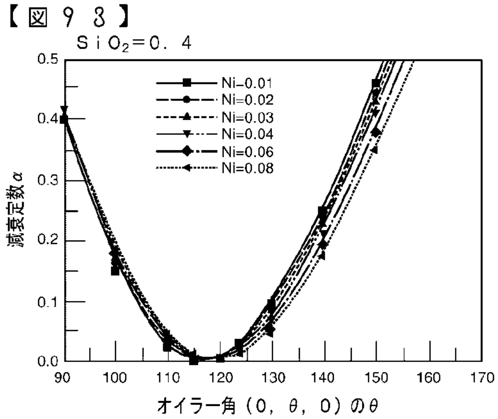
【図９１】



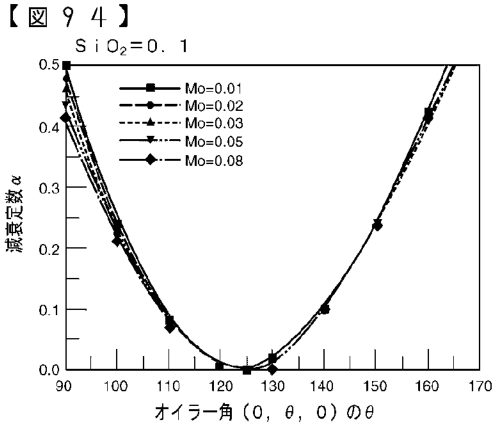
【図９２】



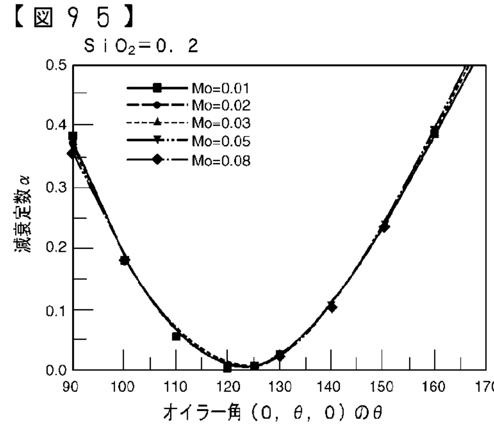
【図９３】



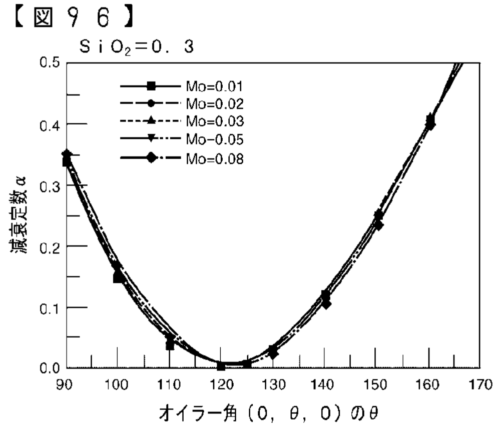
【図９４】



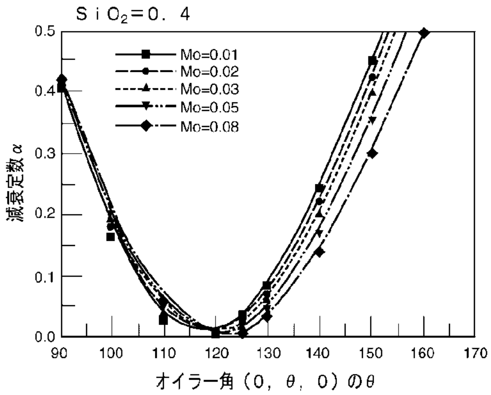
【図９５】



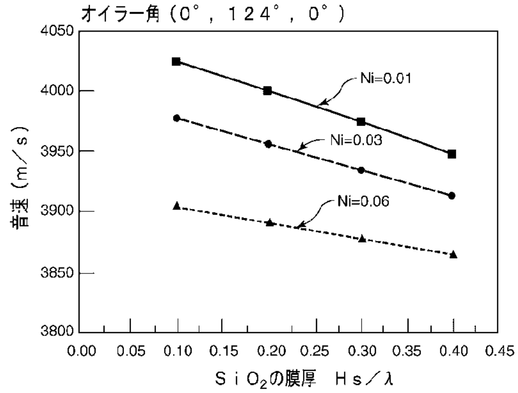
【図９６】



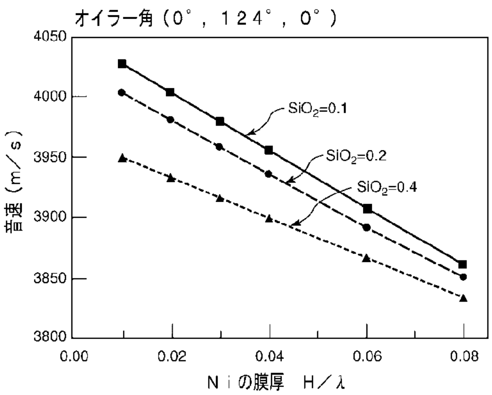
【図９７】



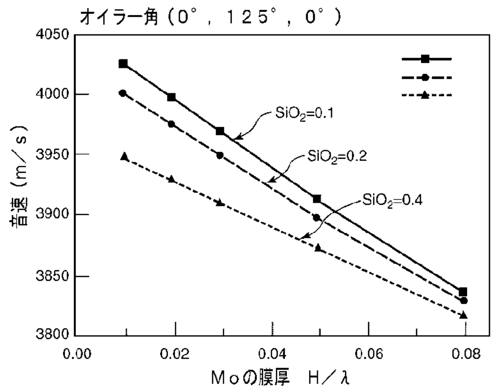
【図９９】



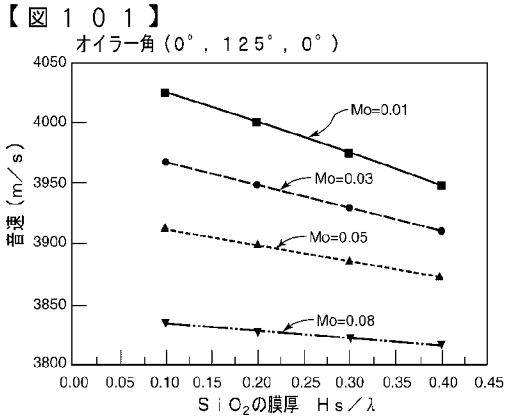
【図９８】



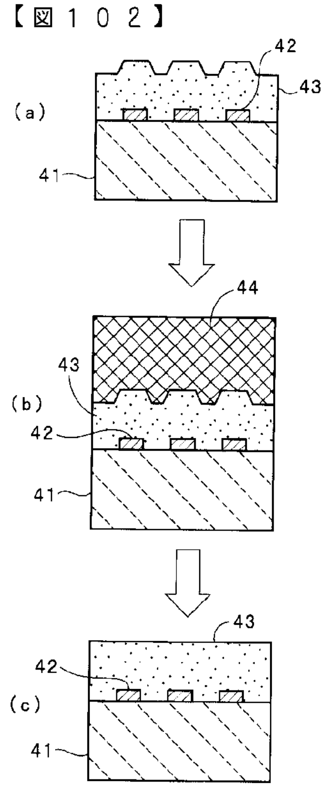
【図１００】



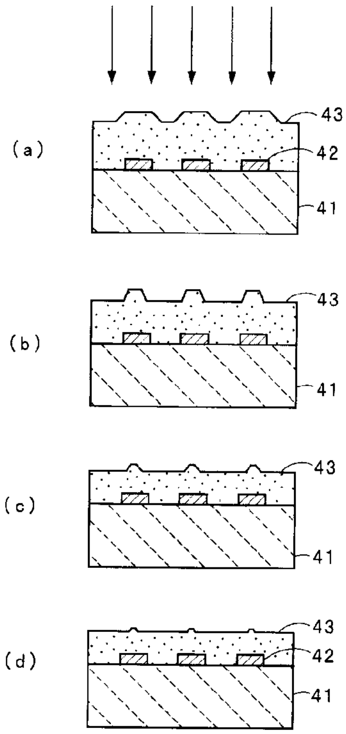
【図１０１】



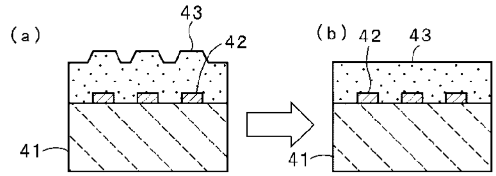
【図１０２】



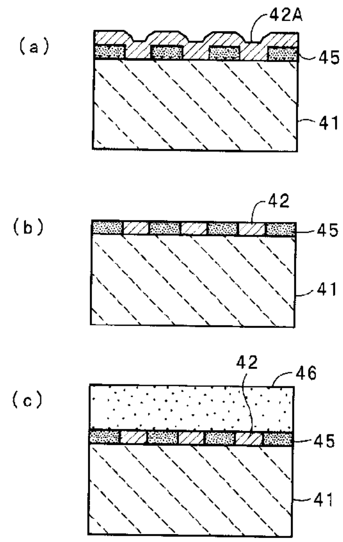
【図１０３】



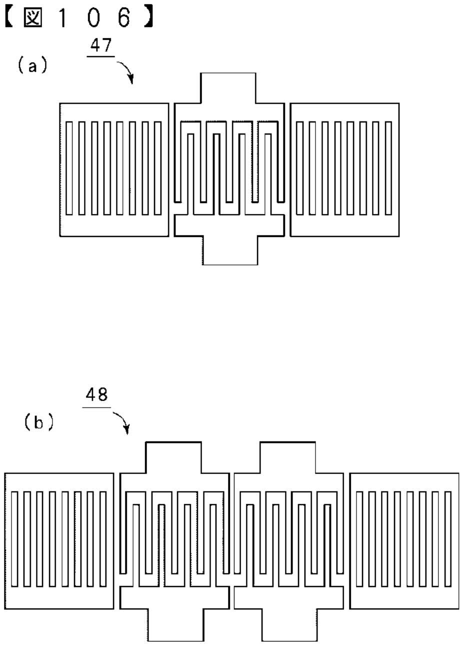
【図１０４】



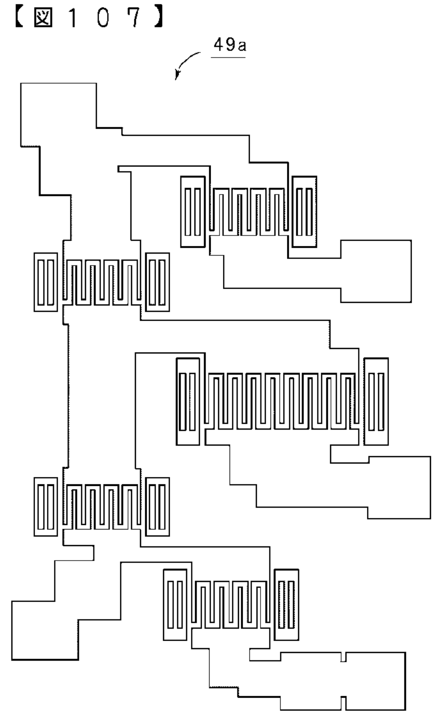
【図１０５】



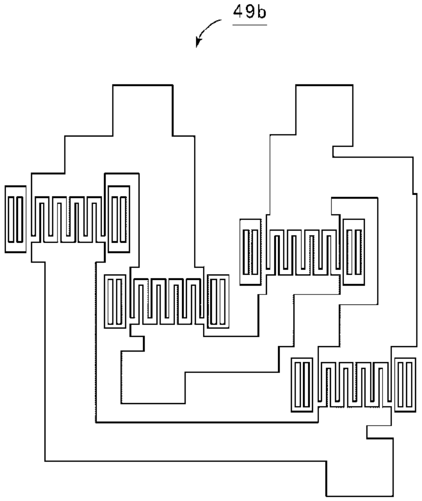
【図１０６】



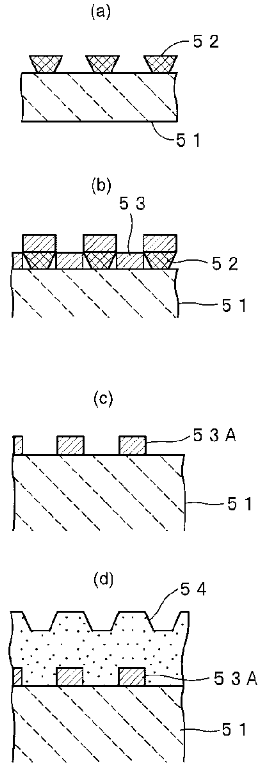
【図１０７】



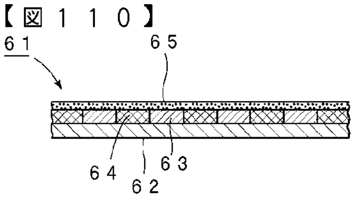
【図１０８】



【図１０９】



【図１１０】



フロントページの続き

Fターム(参考) 5J097 AA13 AA15 AA24 BB01 DD28 DD29 EE10 FF03 FF05 GG03
GG07 HA02 HA03 KK04 KK05 KK09